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PROCEEDINGS OF
THE LINNEAN SOCIETY OF LONDON

149th Session (1936–7) Part 3

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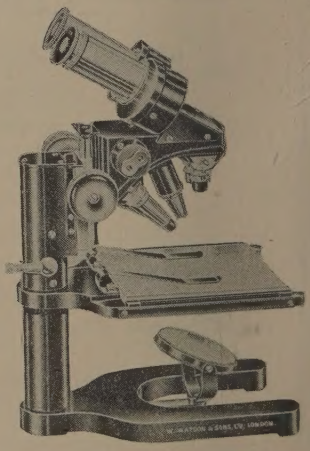

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PROCEEDINGS OF

THE LINNEAN SOCIETY OF LONDON

149th Session (1936–7) Part 3

GENERAL MEETINGS

18 March 1937

Mr. Francis Druce, M.A., Vice-President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 4 March 1937, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted :—Boris Petrovich Uvarov and Charles Kirke Swann.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Hugh Victor Newby, Robert Haynes Jeffers, and Tom Clifford Denston ; for the first time, in favour of Alan Campbell Gardiner and Thomas Alan Stephenson.

Some curious radulae. By Lt.-Col. A. J. Peile.

The lecturer gave an account of the under-mentioned radulae, illustrated by diagrams :—

1. *Macrochlamys glauca* (Pfeiffer), with extraordinary development of the central line of teeth (1).

2. *Bullia annulata* (Lamarck), in an early stage showing the gradual development of the adult form of teeth (2).

3. *Peristernia leucothea* Melvill, illustrative of the genus distinguished by asymmetry of the teeth (3).

4. *Octopus vulgaris* Lamarck, with rhythmic variation in the rhachidian tooth (4).

5. The poison apparatus in the *Conidae* (5).

REFERENCES.

(1) Proc. Malac. Soc. xxii, pt. 1, p. 11, March 1936.
(2) Proc. Malac. Soc. xxii, pt. 4, p. 183, March 1937.
(3), (4), (5) Journ. Conchology, xx, no. 10, pp. 300 et seq., March 1937.

Mr. D. J. SCOURFIELD said that he had noticed that in the lantern-slide showing the radula of *Peristernia* the arrangement of the teeth appeared to be repeated in every third row on each side.

Replying, Col. PEILE said that no form of rhythm can be distinguished in the radula of *Peristernia*.

Dr. G. P. BIDDER also spoke.

The Linnaean species of Rauvolfia [Plum.] Linn.

By Dr. A. B. RENDLE, F.R.S., F.L.S.

[PLATE 3]

LINNAEUS (Spec. Plant. ed. 2, p. 303) recognized two species of *Rauvolfia* (Apocynaceae)—*R. nitida* Jacq. and *R. canescens* L. The species are readily distinguished by the characters suggested by their respective epithets; the one glabrous with leaves shiny on the upper face, the other with the young stems and lower leaf-face shortly and softly hairy; *R. nitida* has also larger flowers and fruits. The genus was founded by Plumier and named in honour of Leonard Rauwolff (1528–88), who travelled widely in the East, and published an account of his travels, including notes on the plants, 'Raiss . . . inn die Morgenländer' (1583). Plumier wrote *Rauvolfia* (there being no 'w' in Latin), as also did Linnaeus, Patrick Browne, and Jacquin; but modern botanists have preferred *Rauwolfia*, a correction that transgresses Art. 70 of the International Rules—the original spelling should be retained, being neither 'a typographic or clearly unintentional orthographic error'. From the time of Linnaeus there has been confusion, originating with Linnaeus himself, in the nomenclature of the two species. The story is as follows:—

Plumier founded the genus in his 'Nova plantarum Americanarum genera', p. 19, t. 40 (1703), with two species:—

Rauvolfia tetraphylla angustifolia.
Rauvolfia tetraphylla latifolia.

There is no further description.

Linnaeus, in the 'Hortus Cliffortianus', p. 75, t. 9 (1737), includes one species of *Rauvolfia*, which he says he saw in

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Rauwolfia [illegible] canescens

RAUVOLFIA CANESCENS HERB. LINN.

flower in the Chelsea Garden, and of which he includes a figure—' Plantam primum florentem videre licuit in Horto Chelseano ubi eandem depingi curavi, at Botanicorum oculis hic subjicimus '. Linnaeus cites both references to Plumier, placing *latifolia* as a variety α. The figure is by Ehret, and was presumably one of the drawings to which he refers in his l tters (see Proc. Linn. Soc. Lond. 1894–5, p. 51) as brought from England to Holland and sold to Clifford while Linnaeus was working at the ' Hortus '. It is a good representation of the softly hairy plants that we have at the British Museum from Miller and the Chelsea Garden. Linnaeus, however, describes the leaves as glabrous, which he might well have done, having only the drawing before him. He remarks that it seems to have much resemblance to the figure in Sloane's ' History ', 2, t. 211, f. 1, which, as we know from the specimen in Herb. Sloane, is conspecific with the Chelsea Garden plant.

Philip Miller (' Gardener's Dictionary ', ed. 6, 1752) assumes that he has both Plumier's species in the Chelsea Garden, grown from seeds sent by Robert Millar from Carthagena, but one species only is represented, the canescent one (*latifolia*), among his plants in the British Museum Herbarium. The glabrous species (*angustifolia*) is restricted to the Greater Antilles, and could not have come from Carthagena. Miller's supposed two species were merely forms of one.

The characters of Plumier's two species were determined when they were described and figured in Burman's edition of Plumier (' Plantarum Americanarum,' continentes plantas quas ipse detexit, et in insulis Antillis ipse depinxit, p. 232, t. 236 ; 1755–60). Plumier's figures bring out the differences in leaf-shape and flower-size between the two—the stalked lanceolate leaves and larger flowers of ' *angustifolia* ' and the subsessile broader leaves and smaller flowers of ' *latifolia* '.

We have at the Museum among Plumier's original paintings one of *angustifolia* (vol. ii. t. 85). Burman (p. 233) suggests the identity of Ehret's figure with Plumier's *tetraphylla latifolia*, and Urban follows him in his account of Plumier's drawings. Neither Burman nor Urban had seen the Chelsea Garden plant.

The confusion in nomenclature between the two species arises from a difference of treatment by Linnaeus in the first and second editions of the ' Species Plantarum '. In ed. 1, 1753, he merely repeats his ' Hortus Cliffortianus ', including one species, *tetraphylla*, with a variety, thus (p. 208) :—

tetraphylla Rauvolfia Hort. Cliff. 75, t. 9.
R. tetraphylla angustifolia Plum. Gen. 19.
β. R. tetraphylla latifolia Plum. Gen. 19.
Habitat in America calidiore.

The only plant he knew was that figured by Ehret, to which therefore the name belongs. He knew Plumier's plants only from the three-word diagnoses.

In 1760 Jacquin (Enum. Syst. Pl. in Ins. Carib. p. 14) briefly diagnosed three species of *Rauvolfia* :—

nitida	1. Rauvolfia nitidissima.
hirsuta	2. —— hirsuta Brown. Jam. t. 1, p. 180.
tomentosa	3. —— tomentosa.

The species are fully described in his ' Selectarum Stirpium Americanarum Historia ', 47 & 48 (1763). *R. hirsuta* and *R. tomentosa* are conspecific ; the latter is figured in Jacquin's ' Observationes ', ii. t. 35, and in his ' Selectarum Stirpium Americanarum Historia ', Ed. Pict. t. 46 : the original specimen from Herb. Jacquin is in Herb. Banks. at the British Museum. Jacquin ignores Linnaeus's name *tetraphylla* and misapplies Plumier's names ; perhaps he was not familiar with Burman's edition.

In ' Species Plantarum ', ed. 2 (1762), Linnaeus has two species :—

1. nitida. R. glaberrima nitidissima Jacq. Amer. 14.
   Rauvolfia Hort. Cliff. 75, t. 9.
   R. tetraphylla angustifolia Plum. Gen. 19. ic. 236, f. 1.
   Hab. in America meridionali.

2. canescens. R. subpubescens.
   R. fruticosa, foliis verticillatis tenuissime villosis Brown. Jam. 180.
   R. tetraphylla latifolia Plum. Gen. 19 ic. 236, f. 2.
   Solani fructu fruticosa &c. Sloan. Jam. 173, Hist. ii. 107, t. 211, f. 1.
   Arbor Sycophora jamaicensis, foliis minoribus Pluk. Phyt. 266, f. 2.
   Hab. in Jamaica.

In the interval between his two editions Linnaeus had presumably seen Burman's edition of Plumier, and now recognises Plumier's two species as distinct. He had also acquired Patrick Browne's Jamaica plants (1758) on specimens of which he founds his second species, *canescens*, including also the references to Sloane and Plukenet. Browne's specimen in the Linnaean herbarium is written up thus : ' *Rauvolfia* ~~*tetraphylla*~~ *canescens* ' ; *Rauvolfia tetraphylla* is in Solander's hand : we know that Solander wrote up many of the specimens in the herbarium and he presumably took the name from Linnaeus's copy of Browne's ' History of Jamaica ', where

Linnaeus has written ' tetraphylla ' in the margin against Browne's description: *canescens* is in Linnaeus's hand, evidently an after-thought.

Why did Linnaeus alter the name ? Was it because on second thought he considered Browne's plant to be distinct from the plant figured in his ' Hortus Cliffortianus ', which he had named *tetraphylla* in his ' Species Plantarum ', ed. 1 ? But, if so, why does he prefer for the ' Hortus Cliffortianus ' species Jacquin's epithet *nitida* of 1760 to his own *tetraphylla* (1753) ? Or did he reject *tetraphylla* because both species are tetraphyllous ? Further, why does he ignore for his second species, *canescens*, Jacquin's earlier epithet *hirsuta* (1760), based on the reference to the same plant of Patrick Browne's ?

Linnaeus correctly assigns Plumier's two species, and also the reference to Sloane, but errs in quoting Plukenet under *canescens*. Both Sloane's and Plukenet's specimens are in Herb. Sloane—the former is ' *canescens* ', the latter *nitida*.

It is fortunate that the possession of the original specimens enables us to clear up the muddle.

There is also in the Linnaean herbarium a specimen of *R. nitida*, so-named by Linnaeus, but acquired subsequently to the date of ' Species Plantarum ', ed. 1, as it occurs only in the third enumeration (1767) ; the sheet bears no indication of collector or habitat. It shows that Linnaeus had at that later period a correct conception of the species.

The synonymy is as follows :—

Rauvolfia tetraphylla L. Sp. Pl. 208 (1753) (excl. syn. *R. tetraphylla angustifolia* Plum. Gen. 19) (incl. var. β).
R. tetraphylla latifolia Plum. Gen. 19 and Pl. Amer. (Burm.) 232, t. 236, fig. 2.
Rauvolvia Hort. Cliff. 79, t. 9.
R. hirsuta Jacq. Enum. 14 (1760) and Select. Stirp. Amer. Hist. 47 (1763) (excl. syn. Plum.).
R. tomentosa Jacq. Enum. 14, Select. Stirp. 48, and Ed. Pict. t. 46, and Observat. ii. 9, t. 35.
R. canescens L. Sp. Pl. ed. 2, 303 (1762).

R. nitida Jacq. Enum. 14 (1760) and Select. Stirp. Amer. 47 (1763) (excl. syn. Plum.) ; Linn. Sp. Pl. ed. 2, 303 (excl. ref. Hort. Cliff.).
R. tetraphylla angustifolia Plum. Gen. 19, Pl. Amer. (Burm.) 232, t. 236, fig. 2, and Icon. Ined. 85.
R. tetraphylla L. Sp. Pl. 208 (1753) only as regards Syn. Plum.

On the evolution of subspecies, as demonstrated by the alternation of variability existing in the subspecies of the genus Erebia (Lepidoptera). By Mr. B. C. S. Warren. (Communicated by Prof. G. D. Hale Carpenter, M.B.E., F.L.S.) [Abstract.]

The genus *Erebia* includes 69 species, comprising 224 subspecies and 90 forms. This paper is based on a systematic study of 205 of these subspecies; and, as the degree of variability can differ greatly in different subspecies of a single species, the subspecies is taken as the unit.

It is demonstrated that the activity of variability observed is of dual nature, affecting the superficial and structural features in unequal intensity. The subspecies are dealt with in five classes, according to the degree of variability, and these classes are shown to be connected by subspecies of a transitional nature, the last and most remote class being connected in this manner to the first, as well as to the preceding class. It is shown that throughout these classes the activity of variability is developed in a regular sequence; almost non-existent in the first class, it increases in the following, and declines in the last, the superficial variability always in advance of the structural, so that the former has attained its peak and is declining when the latter is still increasing. The sequence of this rise and fall is uniform in all species, as is the ratio between the degree of superficial and structural variability in each class. Subspecies of a single species can occur in two classes, thus disclosing the existence of intra-specific alternation in the activity of variability. Eleven species exhibit this phenomenon, which does not affect the inter-specific agreement between the degree of variability existing in the subspecies in each class. It is pointed out that this cycle of varietal activity, owing to its uniformity in all species, must be independent of external influences or differing specific constitutions; it is suggested that it must represent the manifestation of some unknown activity appertaining to the nature of living matter, and implies a perpetual activity of variability. Alternation in the spheres of varietal activity having been shown to be an inherent characteristic of variability, it follows that this phenomenon must be of perpetual recurrence, and it is suggested that the absence of visible variability in the first class must coincide with some further invisible activity, resulting on alternation, which can only imply physiological change. It is further assumed that the evolution of subspecies is dependent on this recurrent cycle of variability, and that the classes dealt with represent actual stages through which all subspecies pass in the course of their evolution.

Professor HALE CARPENTER expressed appreciation of Mr. Warren's laborious and careful work, and hoped that the same kind of research on the relationship between structural variation and superficial variation in colour and pattern, with the study of the distribution of forms, would be repeated for other animals or plants. He regretted that a meeting of the Genetical Society on the same night had prevented geneticists from attending the Linnean Society, as they were far more competent than he was to discuss the theory of cycles brought forward by Mr. Warren.

Captain C. DIVER said that he was greatly interested in the paper, but would like time to consider Mr. Warren's conclusions in greater detail before expressing an opinion on them. He considered that such detailed studies of the variability shown by groups of closely allied species were extremely valuable. Mr. Warren was to be congratulated on the mass of information he had collected and analysed.

Dr. B. P. UVAROV also spoke.

8 APRIL 1937

Dr. W. T. CALMAN, C.B., F.R.S., President, in the Chair

The Proceedings of the General Meeting held on Thursday, 18 March 1937, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws, and were admitted :—Margaret Trevena Martin, Eileen Sutton, and Gian Singh Bhatia.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Alan Campbell Gardiner and Thomas Alan Stephenson ; for the first time, in favour of Carl Frederick Abel Pantin and Hugh Bamford Cott.

Certificates of recommendation of the following candidates for Foreign Membership were read for the first time :—Reinhard Dohrn, Herman Augustus Spoehr, Erik Andersson Stensiö, Nils Eberhard Svedelius, and Richard Woltereck.

Certificates of recommendation of the following candidates for Associateship were read for the first time :—Thomas Hay and Francis Rilstone.

The President announced that the Council had resolved unanimously to award the Linnean Gold Medal for 1937 to Dr. Frederick Frost Blackman, F.R.S.

In accordance with Chap. X, Sect. VII of the Bye-Laws, the following Fellows were elected, by show of hands, as Auditors of the Treasurer's accounts for 1936–7 :—

Representing the Council :	Mr. D. J. Scourfield, I.S.O.
	Dr. B. Barnes.
Representing the Fellows :	Mr. J. R. Norman.
	Prof. W. Neilson Jones.

The President reported the deaths of Her Grace the Duchess of Bedford, D.B.E., and Dr. Harold Downes, Fellows of the Society.

Regeneration in certain brown algae.

By Dr. E. M. Delf, F.L.S.

Regeneration was defined as including not only restoration of lost parts, but also production of new shoots from mature organs, when no previous loss has occurred.

Amongst the Fucaceae regeneration was stated to be fairly common in certain genera. Illustrations were given of *F. vesiculosus* Linn., showing regeneration of shoots from the basal disk, from the stipe after injury, and also from the stipe after burial in the mud of a saltmarsh. Reference was also made to other examples.

It was recalled that within the group of the Laminariaceae the thallus normally dies back after the period of fertility, and is regenerated from a permanent meristematic region.

Apart from this, regeneration within the group was rare, exceptions being *Laminaria Sinclairi* (Harv.) Farlow, *L. longipes* Ag., and *L. Rodriguezi* Born., in each of which new shoots are thrown up from the spreading branches of the basal haptera. Specimens of *L. Sinclairi* exhibiting this habit were shown. The creeping habit of *Macrocystis* (*pyrifera* ?) was also illustrated.

Finally, there was shown the thallus of a new and rare proliferating *Ecklonia*, sent by Mr. V. W. Lindauer from the Bay of Islands, New Zealand. This resembled a youthful stage of *Ecklonia Richardiana* J. Ag., but was thinner and softer in texture, also more markedly toothed. Later stages of the same plant showed that many of the teeth proliferated into haptera of cylindrical or grooved form and straggling, slightly branched habit (see figure). Mr. V. W. Lindauer believes that these provide peripheral holdfasts, and that when the central part of the thallus has broken away, each can establish a new plant.

No fertile stage had as yet been found, so that it was impossible to say whether this was a juvenile form of a hitherto

Outlines traced from photographs of herbarium material of Mr. V. W. Lindauer's *Ecklonia*. *a*. Pinnate stage, resembling *E. Richardiana* (Turn.) J. Ag. in form (but not in texture). *b*. Two lower pinnae have proliferated into haptera, the upper part dying away. *c*. The development of a number of proliferations has resulted in a somewhat shapeless thallus, the upper part of the original pinnate stage having now been lost.

Note.—Specimen *a* is about 28 cm. in length; *b* is 30 cm., and *c* 28 cm. across widest part.

unrecognised adult, but, apart from this question, the manner of proliferation and of probable vegetative multiplication was unique amongst the higher brown algae.

Dr. W. Randolph Taylor (Visitor) said that a suggestion has been made that the problem of algal regeneration could be more clearly analyzed if instances of growth—normal or otherwise—from persisting meristems be set aside and attention concentrated upon regeneration in a more strict sense from ostensibly adult tissues. The most effective approach was suggested to be experimental, with the use of auxins or synthetic chemical growth-stimulants as a part of the procedure.

The President also spoke.

An account of a Botanical Survey of Dorset.

By Mr. Ronald Good, M.A., F.L.S.

The field studies which I have the pleasure of describing to the Society this evening, and which I call for convenience 'A Botanical Survey of Dorset', are the outcome of experience gained during earlier work on the geographical distribution of the flowering-plants. In the course of this earlier work it became increasingly plain that there was an urgent need for much more accurate and detailed information regarding the actual distribution of plants in the field than was available; and the Survey was undertaken with the object of procuring at least a measure of such information.

The immediate and primary aim of the Survey is the production of a large number of maps, all of the same area, and each showing the distribution, within that area, of a single plant-species, the maps being designed and compiled in such a way that they can be directly and accurately compared and contrasted. The ultimate aim of the Survey is to make these comparisons and contrasts, and to study the evidence which they afford as to the reasons which cause them. It is anticipated that when this is done considerable light will be thrown on the nature of the factors controlling the range of species, and their presence and absence. It will also be possible to write from the material collected in the course of the Survey not only a full account of the contemporary vegetation of the county, but also a comprehensive study of the plant-ecology, but both these objectives are secondary to that of producing species-maps.

The area covered by the Survey is the County of Dorset, which is peculiarly, and perhaps uniquely, suitable for the purpose on account of its size (approximately 1000 square miles), its good communications, its maritime and southern situation, its large amount of natural vegetation, and in the almost unparalleled variety of its geology and relief. Moreover, its topography has long been well known to me, and this has saved a great deal of time and labour. The Survey was commenced in 1931; and I estimate that three more years' work will be necessary before the whole county has been sufficiently closely surveyed to warrant bringing the investigation to a close.

The method employed in making the Survey follows almost inevitably from the nature of the study. In working out the distribution of a single species in the field it is possible to proceed from plant to locality—that is to say, to seek out the plant and then to make notes of its geographical situations; but in working out the distribution of a great number of species simultaneously it is necessary to reverse this process—

that is to say, to select areas and to note all the species occurring therein.

The latter is the method I have adopted, and which I venture to call the 'stand' method. It is a very simple one, and indeed consists of no more than making great numbers of lists of species, each list being made at a definite and recognizable spot. Each such list is, in fact, a description of a single example of one plant-association, and thus may accurately be described by the term 'stand' *. As far as possible every location at which a stand is made is a reasonably distinct topographical and ecological entity, such as a wood, a length of hedgerow, a marsh, a field, or an area of heath.

It will be apparent that if sufficient stands are taken they will actually comprise together the whole area of the county, and will afford a complete description of the vegetation; but in practice the time-factor makes any such degree of completeness unattainable, and fortunately it is not essential for the purpose of mapping. Nevertheless, it is an essential of the stand-method that the stands shall be as numerous and as evenly scattered as possible. Actually up to the present some 5600 stands have been made, incorporating upwards of quarter of a million plant-records, and a map which I shall exhibit shows the degree of density which this figure, an average of 5·6 stands per square mile, gives. It is estimated that in three more years' work the number of stands will be increased to about 8000.

For the purpose of mapping the species a special map of the county on a scale of $\frac{1}{2}''$ to the mile has been prepared. It cannot be described in detail here, and it must suffice to say that it has been designed so that all the distributions plotted on it are directly comparable and so that an accuracy, in plotting, of 220 yards linear is obtained. This, in my opinion, is the limit of accuracy compatible with clarity.

In theory it is possible by the stand-method to make maps of all the species in the flora, but in practice this is more than can be hoped. At present I cannot say how many maps will eventually be made, but it will certainly be more than 250, and I hope may be 500.

My account of the Survey this evening is illustrated by specimen-maps of some dozen species, but it must be remembered that, as the work is still going on, these are not in their final state. I propose also to illustrate a special study I have made on rather different lines of the distribution of the Primrose (*Primula vulgaris*) in the County. This plant affords a particularly interesting example of the rather unexpected results obtained when the distribution of what is generally regarded as a common plant is worked out in detail.

* See Braun-Blanquet (trans. Fuller and Conard), 'Plant Sociology', p. 23 (1932).

The work of the Survey has involved considerable expense, not only in dealing with the great mass of data collected, but also in the large amount of road travelling incurred, and it is a great pleasure to me to be able to express here my great indebtedness to the Trustees of the late Lord Leverhulme for the grant which they made two years ago in aid of the work. Without it the Survey could not have continued.

It is also necessary for the purposes of the Survey to visit all parts of the county, and I am most grateful to the many landowners who have not only allowed me to visit their private estates, but have given me all the facilities at their disposal.

Dr. A. B. Rendle commented on the great interest of Mr. Good's maps. Those illustrating the distribution of the species of *Hypericum* presented suggestions and problems. He asked whether the speaker included in the results of the Survey previous records such as those of Mansel-Pleydell's 'Flora of Dorset'.

Sir Albert Seward congratulated Mr. Good on the progress of his Botanical Survey of Dorset: it was, he said, encouraging to know that the great subject of geographical distribution was being tackled on promising lines likely to lead to results of fundamental importance.

Captain Diver said that he had the advantage of seeing Mr. Good at work in the field, and the method employed produced the most valuable results. A total of 5600 stands was in itself a remarkable achievement, since each stand averages between 40 and 50 species.

Mr. J. S. L. Gilmour asked Mr. Good to what extent he recorded ecological, soil, and other similar data for each individual stand.

Prof. F. E. Weiss and Dr. H. Hamshaw Thomas also spoke.

In reply to Dr. Rendle, Mr. Good said that his Survey included only records which he himself had made during the period of the work. Incidentally, however, many of Mansel-Pleydell's records have been confirmed. In answer to Mr. Gilmour, Mr. Good stated that the exact localization of each stand provided much information concerning ecological conditions. In addition, other appropriate notes were made as far as time allowed.

Leaf-form and structure in the genus Crocus, illustrated with photo-micrographs.—I. By E. J. Collins, M.A., D.Sc., F.L.S. [Abstract.]

Although Maw, in his monograph of the genus, which was published in 1886, gave a plain outline of the cross-section of the leaves of many of the species he described, there does

not appear to be any detailed description of the form and structure of the leaf in the genus. A systematic examination of the leaf of all the species and forms in the collection of the John Innes Horticultural Institution was undertaken in the hope of securing additional characters which might serve taxonomic purposes in the group, individuals of which have been in garden-cultivation for a long period, with the consequent disadvantages of tangled ancestry. It has been found that form is of definite value, and ancillary characters, such as the nature of the epidermis, the distribution of the vascular tissue, the presence of stereome and crystal-containing cells, the differentiation of the mesophyll, the distribution of the stomata—all characters seemingly correlated with the environment, yet apparently specific—are of considerable significance in diagnosis. Some account is given of the leaf of the better known garden forms, *C. aureus*, ' Dutch Yellow ', and *C. vernus*, a ' Dutch ' deep purple type, and *C. chrysanthus*, var. ' E. A. Bowles ' a garden-derived form of *C. chrysanthus*. Although cultivated types have been examined, it has been realized that considerable interest lies in the examination of recent wild-collected forms and the comparison, so far as possible, of these with their like which have been in cultivation for considerable periods.

The wild-collected species, *C. carpetanus* Boiss. & Reut., from the Serra da Estrêla, *C. Cambessedesii* Gay, from Majorca, and *C. nevadensis* Amo & Campo, from the Sierra Nevada, are described. The author is indebted to Mr. A. W. Exell, F.L.S., for the first two species, and to Mr. T. A. Lofthouse, F.L.S., for the last-named. Each of these species has leaf-characters which make it easy of identification. The plants of *C. carpetanus* had a chequered existence after transportation in full flower, and the single leaf subsequently arising from each small corm was undoubtedly abnormal in the circular outline and approximate radial symmetry of its cross-section. A comparison with the leaf of an authentic specimen of the species, kindly supplied through the courtesy of the Keeper of the Botany Department, British Museum (Natural History), was made, and also with the radially symmetrical leaf-type of *Romulea* sp. (Herbae caulescentes humiles bulbosae). Consideration was given to the question of the relative primitiveness of such a leaf-type in the genus, since the outermost sheathing leaves of the axis are tubular, and occasionally assume a definite foliar character toward the apex.

The cross-section of the leaf of *C. nevadensis* is marked by the broad keel, and the presence of stomata in the epidermis of the keel and upper surface of the shortened wings, an unusual feature in the epidermal structure of members of the genus.

In *C. Cambessedesii* the identifying character is the peculiar nature of the epidermal cells of the keel which are elongated at right angles to the surface in a graded sequence from the edge to the centre.

The paper is illustrated with reproductions from photomicrographs; for technical assistance in the preparation of these I am indebted to Mr. H. C. Osterstock of the John Innes Institution.

22 April 1937

Dr. W. T. Calman, C.B., F.R.S., President, in the Chair

The Proceedings of the General Meeting held on Thursday, 8 April 1937, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Carl Frederick Abel Pantin and Hugh Bamford Cott; for the first time, in favour of Frederick Ronald Hayes.

Certificates of recommendation of the following candidates for Foreign Membership were read for the second time :—Reinhard Dohrn, Herman Augustus Spoehr, Erik Andersson Stensiö, Nils Eberhard Svedelius, and Richard Woltereck.

Certificates of recommendation of the following candidates for Associateship were read for the second time :—Thomas Hay and Francis Rilstone.

Exhibit of fruits of the so-called graft-hybrid known as "Citrus Bizzarria". By Miss M. S. Campbell, F.L.S.

All fruits were from one tree growing at Casa Rossa, Mentone, France, where the exhibitor's father, Dr. J. W. Campbell, has his collection of *Citrus* trees.

A summary of the botanical history of this incompletely understood plant is given by Strasburger in his 'Rambles on the Riviera' (ed. 2, pp. 62–63).

Professor F. E. Weiss expressed his interest in the exhibit. The original bizzaria orange was raised in Florence in 1644,

and was produced by grafting a scion of Orange on a Citron-Lemon stock. Presently a branch arose bearing both lemons, oranges, and fruits partaking of the nature of both. This curious plant is described in vol. ii. of the 'Philosophical Transactions of the Royal Society, 1731', and is also mentioned by Darwin in 'Animals and plants under domestication'. It was generally regarded as a graft-hybrid, which was supposed to have arisen by the union of vegetative cells of the scion and the underlying stock at the point of insertion. Strasburger, who studied the earlier records very closely, came to the conclusion that the phenomenon was due to somatic segregation in the case of a hybrid stock. This view was partly due to the fact that similar bizzaria oranges had occurred elsewhere too. Frost, after considerable experience of the cultivation of various forms of Citrus in California, believes that bizzaria oranges can be produced both by grafting and also from seed-hybrids. It is usual now to regard graft-hybrids as chimaeras in which the tissues of both the stock and the scion grow either side by side as sectorial chimaeras or more intimately mixed as in the specimens exhibited, which show both a sectorial and a Mosaic arrangement of orange and lemon rind. Such chimaeras can be readily propagated by cuttings.

The perfection of sponges.

By G. P. Bidder, Sc.D., F.L.S.

According to Linnaeus: '*Lapides* crescunt; *Vegetabilia* crescunt & vivunt; *Animalia* crescunt, vivunt, & sentiunt''*. Under this definition the sponges were properly placed among the vegetables, and if the definition were still accepted there they should remain—although in my view they are ancestors of nearly all many-celled animals—for unquestionably they have no 'sentience'. They are animals but they are not animate. They feed on solid food, cannot make starch from carbon dioxide, and they perform a considerable amount of mechanical work, for which they possess a remarkably perfect hydraulic engine; but they have no brain, no nervous system, no continuity of protoplasm. Their cells are as independent of each other as their descendants, our blood corpuscles; as with those, so in the sponge, by every cell doing his own job thoroughly, minding his own business only, the welfare of the whole is maintained. Anthropomorphism and the pathetic fallacy are illusions from which it is impossible to clear our thoughts altogether; it may therefore be useful to consider

* Syst. Nat. ed. 1, 1735, *sub* 'Observationes in Regna iii Naturae'.—I owe to Mr. S. Savage, F.L.S., this reference to the origin of the well-known definition.

an animal, more perfect than man, winning its living by active physical work efficiently performed; yet an animal that has no thought, no mind, no pleasure, and no sensation. Each cell follows its instinct, purposeless and uninstructed; the sum total of their several careers resulting in perfect life for the community—a community without communion, in perfection as a whole with blind isolation of the parts.

Sponges are more perfect than man, for two reasons. Firstly, they are enormously older. A fortunately preserved group of young sponges described by Hinde * shows us that the *Leuconia fistulosa*, of the English Channel, with not more than varietal difference, inhabited the waters over the English Midlands in the Jurassic Age—say, 80 million years ago, when our ancestors were newts. *Leuconia aspera*, the subject of my experiments at Naples, I think may be identical with an American fossil of Silurian age †—say, 400 million years ago, when our ancestors were fishes with round mouths and no jaws. Sponges are the first and oldest many-celled animals ‡, and must have come into being 1000 or 1500 million years ago.

The second reason for their superior perfection is that during the whole of that time they have lived the same life, and that the Jurassic sea over Staffordshire was just as suitable to *Leuconia fistulosa* as the Channel is now. Whereas, even in the last 5000 years, our environment has changed so much that the qualities which won success for our dolichocephalic ancestors bring us to the gibbet.

That the sponge has no sensation follows from the fact that its cells are not protoplasmically connected §. A critic may say this means merely that histological methods used have not yet shown connections, but my conviction, from observation of the living collar-cells, is based especially on the complete absence of co-ordination between the movements of flagella, even on two neighbouring cells. Neither the plane nor the period of vibration of the flagella is the same, except by rare haphazard (fig. 1). Flagella near each other, being in similar environment, have generally nearly the same period of vibration, but it is not exactly the same. I thought once that nervous connection and

* *Leucandra Walfordii* Hinde, 1893, pt. iii, pl. xix, fig. 8. The stalk is not shown, but the characteristic hemispherical base and wide vent are unmistakable. The spicules are rather smaller than those in recent adults. *Leuconia fistulosa* is a wide-mouthed calcareous sponge about the size of a little finger, shaped like an old cannon, but with a stalk from the breech like a pig's tail, on which it twirls with the tide so as always to point down stream.

† *Rauffella filosa* Ulrich, 1893, pl. F, figs. 16–18. Described as a Hexactinellid for reasons not evident—probably because of its antiquity.

‡ Bidder, 1927, p. 70.

§ Cf. Minchin, 1908, p. 323.

co-ordination were proved when I saw two adjoining cells with flagella beating in parallel planes, keeping time and phase exactly with each other, both to the north together, both to the south together. After a little I began to be doubtful about the exactness; after a few hundred beats they were still apparently at the same rate, but one was behind half a vibration with flagellum to the north when the other was to the south. The only connection ascertainable between two flagella is when, as often happens, they strike each other.

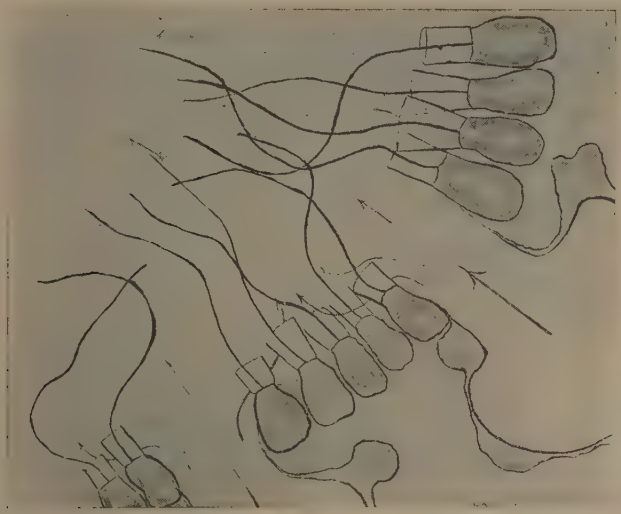

Fig. 1.—Flagella of *Leuconia*.

The tip of the flagellum is adhesive, and in the rare case when two tips happen to touch, they cling together, and the two flagella wrestle against each other, sometimes for a long time, before a fortuitous coincidence of effort tears the sticky tips apart. When, from poisoning or increased salinity of the surrounding water, a flagellum has come to a standstill, it may be started again by a blow from a neighbouring flagellum, as it may by a flash of strong light.

Co-ordination of the flagella is unnecessary, because their immediate duty is not to produce velocity but to maintain pressure, their movement is 200 times as fast as the tiny current past them and, as in an electric fan, is across the direction of flow. Calling that direction 'upwards', it does not matter

toward what point of the compass the flagellum vibrates so long as the slope of its moving curve wedges the water away, in the manner of a fish's tail (fig. 2).

Except when overlaid, I have never seen a flagellum stop for any reason but because it was dying, and each one waves independently of every other cell in the sponge.

Beside the flagellate cells there are in *Leuconia* three other main classes of cells: contractile cells, spicule cells, and reproductive cells (with which I provisionally include wandering amoeboid cells, further discussed in the postscript). None of these show any nervous connection into a whole; as Montagu said in 1814, 'each fraction contains an equal portion of vitality independent of connection'*. For the *contractile cells*, which close apertures and regulate calibre, Parker† found in *Stylotella* that no stimulus of any other part of the sponge induced contraction in them; they must be stimulated themselves: 'the receptor is also the effector'.

Fig. 2.—Particle driven by flagellum.

Stylotella is a finger-shaped siliceous sponge living in warm surfy shallows where the water is full of suspended matter; if for any reason the waves are cut off, the vent of *Stylotella* closes at once, and so the cloaca avoids being choked by the suspended matter settling from the still water. Parker protected the extreme distal part of the sponge with a short length of tube; though over the whole of the rest of the surface there was the sudden change from turbulent to still water, the vent remained open. But if all the rest of the sponge was protected, and only the extreme distal part remained free, the cells surrounding the tip contracted until the vent was closed. In *Leuconia*, *Leucilla*, and *Sycon* the contractile cells are not on the outside of the finger-tip but inside the tube, lining the end of the cloaca inside the vent. They are stimulated to contract, not by slackening of the external wave-motion, but by the slackening of the internal current which passes through the tube, formed by their surface, to be the

* Montagu, 1812–1814, p. 73.
† Parker, 1910, p. 19.

jet from the vent. As they close themselves into a smaller circle the weak outflow is accelerated by the narrowing channel until it takes up a velocity adequate to soothe the sphincter into a new quiescence. In *Leuconia*, just inside the vent, there is an annular membrane well described by Haeckel*, formed of elongated contractile cells. Its aperture is almost the width of the cloaca when the jet is strong, but contracts to a pin-hole (fig. 3) if the tip of the sponge be cut off with

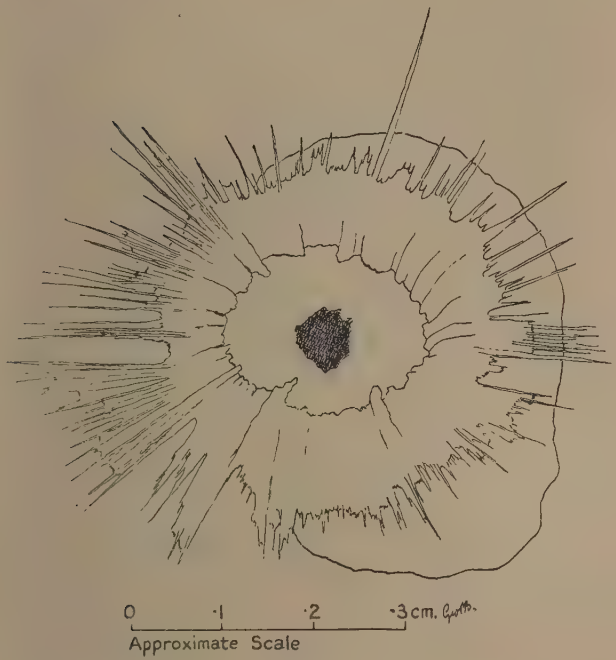

Fig. 3.—Vent of *Leuconia*.

scissors so that the current through it stops. In the imperforate membrane of a young branch (A 45), fusiform cells, with length ten times their thickness, lie with their lengths parallel to the circular edge of the diaphragm; they are only 50μ long, while more central cells are flat, $100\mu \times 18\mu$, and, hardened and stained, show clear spaces between them,

* Haeckel, 1872, i, 267.

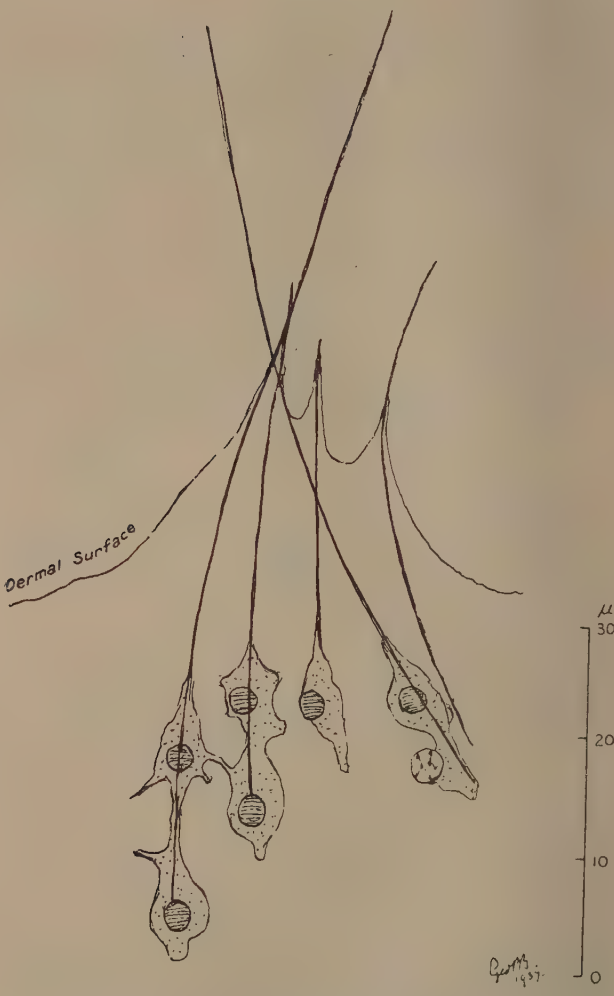

Fig. 4.—Hair-spicules of *Grantia*.

with no sign of any nerve-fibres or other cells whatsoever. In that stage the membrane is only one cell thick*.

* My drawings of living contracted diaphragms show thickened ridges, in one membrane forming a discontinuous lip, in two other membranes approximating to radial thickenings. These were drawn

The *spicule-cells* are grouped in pairs and even in sestets *, but these groups are not bonded with each other. The cells of the pair which gives rise to a calcareous needle-spicule, or one ray of a tri-radiate, show concerted action, and are connected by stellate processes; so that with the spicule decalcified they have been described and figured as ganglion-cell and sense-cell (fig. 4). The cells of one spicule are sometimes

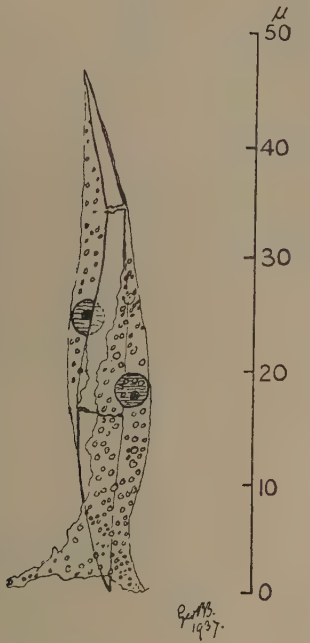

Fig. 5.—Young giant spicule (*Grantia*).

connected with the cells of another, but there is no suggestion in calcareous sponges of a reticulation of spicule-cells co-ordinating the skeleton nor is there any evidence of control of a pair of spicule-cells by other cells (fig. 5).

an hour or two after truncation, and may or may not be pathological—possibly their irregularity is pathological. Dendy (1893, p. 213) found the diaphragm of *Vosmaeropsis* consisting of two epithelia of flat hexagonal cells with a few fusiform cells. Minchin (1892 *b*) in *Clathrina clathrus* found two epithelia of fusiform cells. The evidence is in favour of the active functional diaphragm being composed of two layers of cells.

* Minchin, 1897, p. 506.

The *reproductive cells* are naturally wild rovers. While the flagellate cells and the contractile cells are the most

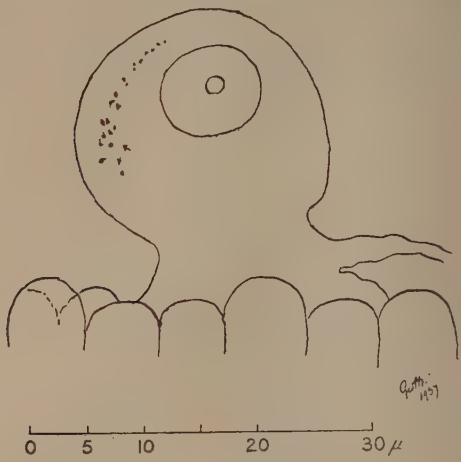

Fig. 6.—Living ovum in chamber cavity.

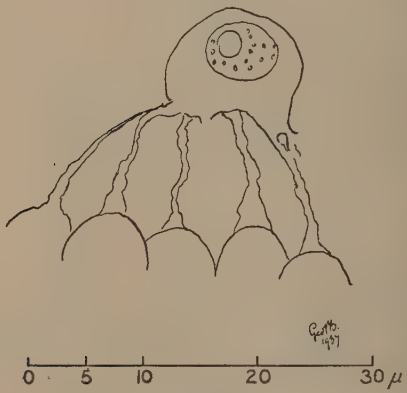

Fig. 7.—Ovum in chamber on converging collars.

machine-like of the sponge-cells, the spicule-cells are much less predictable and the ova show all the apparent autonomy and the apparent avidity of a free *Amoeba*. Whether sucking

greedily their food-reserves from the collar-cells *, or enveloping and devouring some living thing intruding in the mesogloeal jelly, or (in *Sycon*) hastening to the cloacal wall to present a micropyle to the thin epithelial cell and so invite the spermatozoon †, their actions, though only traced in the paraffin section, give the impression of uncontrolled and passionate lawlessness; most of all when, in section or in fresh preparation, ova of *Grantia* are seen in their extraordinary habit of pushing out between the collar-cells and sitting on them, free in the lumen of the flagellate chamber, bathed by the water (figs. 6, 7) ‡. In the light of Gatenby's work § on the spermatozoa of *Grantia*, one guesses that the ovum is in the chamber for direct fertilization, as suggested by Haeckel and Dendy; but when I sketched it alive there, it had taken advantage of its freedom to eat and break up a green chlorophyll corpuscle (fig. 6).

These four classes of cells in the sponge pursue their independent lives, ' like the inhabitants of a town ', as a nineteenth century naturalist wrote ||, ' on the side of a stream from which each takes his food and drink '. Only this town has no Mayor, nor Town Council, nor Police, nor Borough Surveyor. The inhabitants make the canals themselves—there is no natural river, the water is paddled through by a class of the inhabitants who, beside eating, do nothing else; but no one controls them. They paddle ceaselessly and eat ceaselessly, both things unintelligently and without pleasure or pain; no other inhabitant knows anything about them except the marauding ova, which are parasitic on them. We may say that they eat without pleasure; because my collar-cells in *Leuconia* have engulfed, with equal voracity, carmine, starch, powdered charcoal, indigo, Indian ink, carminate of alumina and prussian blue **. (I have identified in them, taken as natural food, bacilli, 16-cell stages of the very minute *Syncrypta spongiarum*, pyrenoid bodies, and a spiral vessel of coniferous wood.) The curious bending over to place the collar in contact with an outwandering ovum (fig. 7) is the only imitation of free-will

* Bidder, 1892, p. 477, fig. 4 B; Dendy, 1893, pl. 14, fig. 50, p. 222; Bidder, 1895, p. 30; Dendy, 1911, fig. 34, and 1914, p. 344, fig. 48.

† Bidder, 1920, pl. 24, figs. 4–6 (cf. Görich, 1903, text-fig. 2).

‡ Cf. Dendy, 1891, p. 30; Bidder, 1895, p. 31; Dendy, 1913, and Bidder, 1913; Dendy, 1914, figs. 11 & 74, and pp. 323, 335; Bidder, 1920, p. 324. Cf. also Haeckel, 1872, iii, Taf. 48, fig. 8.

§ Gatenby, 1920, text-figs. 2–4, and par. 22.

|| I confidently looked for this sentence in Huxley's ' Invertebrata ', and then in his ' Zoological Notes . . . . on board H.M.S. *Rattlesnake* ', but it is not in either work, and, with my apologies, must stand here undocumented. . . . [In proof, a friend suggests Herbert Spencer's ' Biology '.]

** Bidder, 1895, pp. 30, 31.

which I have seen in a collar-cell of *Sycon* or *Grantia* *, though in *Grantia* this is eclipsed by their excited engulfment of spermatozoa, observed by Gatenby (1920). In *Clathrina* when (in still water) the collar-cells are overlaid by intrusive dermal

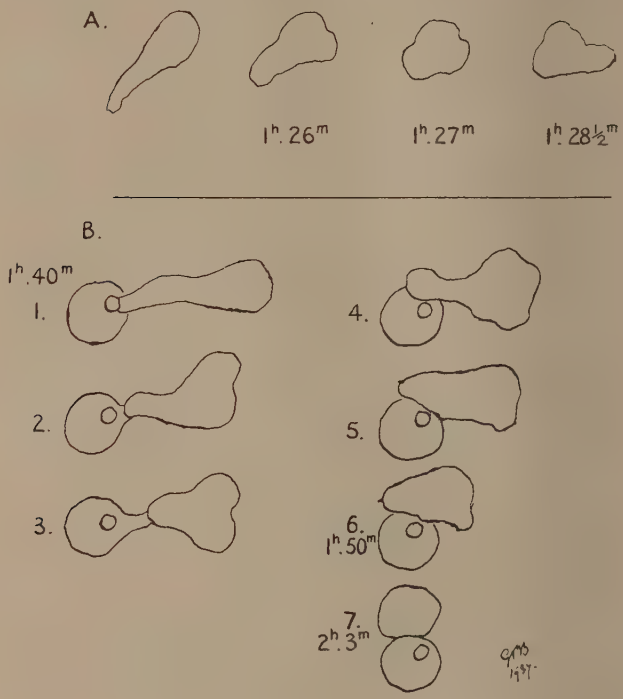

Fig. 8.—Overlaid collar-cells moving (*Clathrina*).

cells † they lose collar and flagellum and, before they settle to the repose which prepares them to form the interior of a resting gemmule ‡ they show the questing movements of hungry protozoa (fig. 8).

* Is the mutual attraction between collar-cells and ova connected with the fact that, in a preparation critically stained with eosin and methyl-blue, the reserve granules of the collar-cells are basiphil and those of the ova are acidophil ? I have also found an acidophil amoeboid cell embracing closely a basiphil pylocyte.

† Cf. Minchin, 1898, p. 487; Bidder, 1892, fig. 2—with wrong hypothesis.

‡ Cf. Urban, 1910, Bidder, 1933 (3rd par.).

Yet, with this complete anarchy and isolated individualism a sponge is so perfectly organized that by the waving of fine flagella, ·4 μ thick or, say, 80 molecules thick, with a maximum speed of ·2 centimetres a second, there issues from the vent a jet of 30 times greater maximum speed. In such a jet, a *Leuconia* (A. 53, on which through the kindness of Professor Dohrn I was able to experiment five years ago) threw, to a distance of 70 cm., 1000 times its own bulk of water per hour, and continued for two days to send its jet from 45 to 60 cm. until it was poisoned with litmus solution (fig. 9). To shift, to a distance of two feet, a ton of water

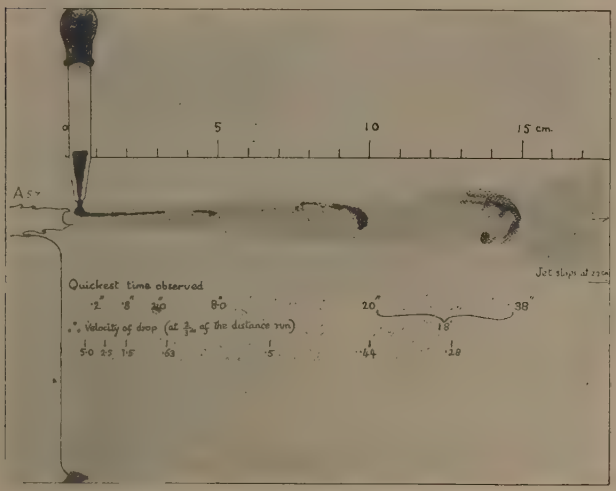

FIG. 9.—Measurement of velocity from vent.

per eight days, is efficient work for an animal, half as large again as a finger, whose only instruments are fine hairs, 80 molecules thick, moving through the water as fast as a slow snail crawls.

I showed in 1923* how those sponges which are not surf-dwellers, nor long-stalked, fan-shaped or cup-shaped, require to send to the greatest distance possible the water from which they have extracted some of the oxygen and all the food, and into which they have ejected their faeces. I showed

* Bidder, 1923, p. 314.

how from a given canal-system, with flagella keeping up a given pressure, only one diameter of vent would give a jet of maximum length, any larger or smaller vent throwing a shorter jet, as with a garden-hose. A calculation was made, tending to show that the sponge investigated had a vent with diameter near the optimum diameter.

This calculation, revised now in the light of fourteen years' work, can be held to prove no more than that the vent of A.11—the *Leuconia* whose canal-system was so laboriously computed—*may* have been of optimum diameter. The diameter measured in spirit was ·20 cm., and in life and full activity would have been probably between ·25 and ·30 cm. Recalculation suggests that the optimum diameter was also between ·20 and ·30 cm., but probably nearer ·20 cm. We can only say that the vent was not far off the best size.

Fortunately, this frontal attack is not the only way of solving the problem. If the vent of *Leuconia* is of optimum diameter, then its area should vary as the quantity of water to be passed varies. But the quantity of water to be passed varies as the number of flagellate cells driving it—that is, with the weight of the sponge. Therefore the area of the vent should vary as the weight of the sponge, and consequently the diameter of the vent should vary as the square-root of the weight, whereas if the sponge grew merely as it grows under a magnifying-glass, the diameter, like all other linear dimensions, should vary as the cube-root of the weight. The weight of A.11 in alcohol is ·12 of that of A.53, whose 70 cm. jet suggests that the vent was well proportioned with its mean diameter, B=·77 cm. We have seen that A.11 had a living B between ·25 and ·30. Proportional to that of A.53 it should have been ·27 cm. if B varies as the square-root of the weight, but ·38 cm. if B varies as the cube root of the weight. It is clear, therefore, that these two highly efficient sponges, one nine times the weight of the other, had the sizes of their vents related as they should be to be of optimum hydraulic efficiency, and not in the ratio of the general linear increase.

A more interesting test can be made, when a sponge is observed in varying conditions of temperature, &c., in the direct change of size in the vent, following by Parker's reaction on increase or decrease in the velocity of the current. If the vent is to remain optimum its area must vary as the velocity of the jet, and therefore its diameter as the square-root of the velocity :— $B \propto \sqrt{V}$. The Table shows that in 12 observations of contraction or expansion half of the diameters showed agreement with this law within ·01 of a centimetre—closer than which I could not profess to measure a single vent,—and in 8 out of the 12 the error is not above ·03 cm., which error covers

errors in the measurements of two diameters and of the length of the jet.

Area of vent varies as velocity of jet.

(Experiment indicates that the velocity at the vent, V, is related to the length of the jet, L, and the mean diameter of the vent, B, at any given temperature by the formula

$$VB \propto L^{5/6}.$$

Therefore, when the area of the vent $\left(= \frac{\pi}{4} B^2\right)$ varies as V; $B^2 \propto V$

$$\therefore \quad B^2B \propto L^{5/6}.$$

$$\therefore \quad B \propto \sqrt[3]{L^{5/6}}, \quad \therefore \quad B \propto L^{5/18}.)$$

Sponge.	L observed.	$\therefore L^{5/18}$.	Ratio to datum	B observed.	Theoretical.	Error from theory.
	cm.			cm.	cm.	cm.
Leuconia aspera.						
A.51 bis.....	5	1·56	1·00	·25	datum	
	3	1·36	·87	·23	·22	+·01
A.57.....	11	1·95	1·00	·48	datum	
	6·5	1·68	·86	·44	·41	+·03
A.50.....	6	1·64	1·00	·32	datum	
	8	1·78	1·09	·26	·35	−·09
	9	1·84	1·12	·37	·36	+·01
	10·5	1·92	1·17	·36	·37	−·01
Leucilla (of published experiment)* on						
July 7....	18	2·23	1·84	·38	·33	+·05
,, 7....	9	1·84	1·52	·35	·27	+·08
,, 8....	7	1·72	1·42	·30	·26	+·04
,, 9....	6·5	1·68	1·39	·25	·25	nil
,, 9....	2	1·21	1·00	·18	datum	
,, 11....	13	2·04	1·68	·32	·30	+·02
,, 11....	8	1·78	1·47	·28	·27	+·01
,, 11....	7½	1·75	1·45	·25	·25	−·01

* Bidder, 1923, p. 314.

It is clear, therefore, that if a sponge—*Leuconia* or *Leucilla*—starts with a vent of optimum size, Parker's reaction will keep the vent to very nearly optimum size during changes in temperature or salinity which may greatly alter the activity of the flagellate cells. But whether or not the observations are held

to support my belief that the diameter of the vent is a strangely close approximation to the diameter of greatest hydraulic efficiency, they undoubtedly prove that in this animal without a nervous system the contractile cells form a governor, regulating the outflow so as to take advantage for the sponge of a period of strength, and to suffer as little as may be from a period of weakness.

Parker's reaction—the contraction of sphincter cells when the movement of fluid over their surfaces becomes slow—is a reaction which I suggest is of great general importance, and inherited in the cells of our capillary veins*. I believe it to be responsible, in the ontogeny of the sponge, for much of the proportioning of calibre to flow in the various canals, whose teleological accuracy would be otherwise so incomprehensible, and the same is probably true in the ontogeny of any vascular system. For that with which we are now concerned, the maintenance of a constantly maximum jet in a small sponge whose flagellar pressure is varying under varying temperature, the simple and beautiful diaphragm suffices—the veil of contractile cells closing and opening on its circular aperture, and so restricting the current when its sluggishness stimulates the cells of the veil to contract. From the newly fixed larva, figured by Schulze, to tubular sponges several centimetres in length and millimetres in width, we see inside the terminal opening the same delicate annular membrane, and can measure its changes. But there seems to be an upward size limit. In A.53 the longest diameter of the vent is 1·4 cm., 7 times the diameter in A.11. If it were circular with this diameter and closed by a membrane against the same pressure, the membrane would require 7 times the tensile strength that it would need in A.11, and perhaps 100 times the tensile strength required in the newly metamorphosed sponge. It is not surprising, therefore, when we fail to find the unicellular veil stretching across the vent of a giant *Leuconia*. Presumably the contractile cells spread themselves over the inner lining of the lips, certainly the vents still change in size. In large sponges which are stout for their length (whether genetically or as a result of rough water) the distal end becomes by natural growth too wide for a vent of natural efficiency, and too solid with spicules to have its circumference contracted. It is therefore pulled out of its circular shape into an ellipse or more irregular outline (fig. 10), thereby diminishing its area to its due proportion. Empirically, where relative growth is such that the middle width of a *Leuconia* is less than one-tenth

* Cf. an interesting paper read at Section D, Brit. Ass. 1936, based on tissue cultures.

of its length, the vent can remain circular, even for a sponge 17 cm. long ; but not if the width is one-eighth of the length ;

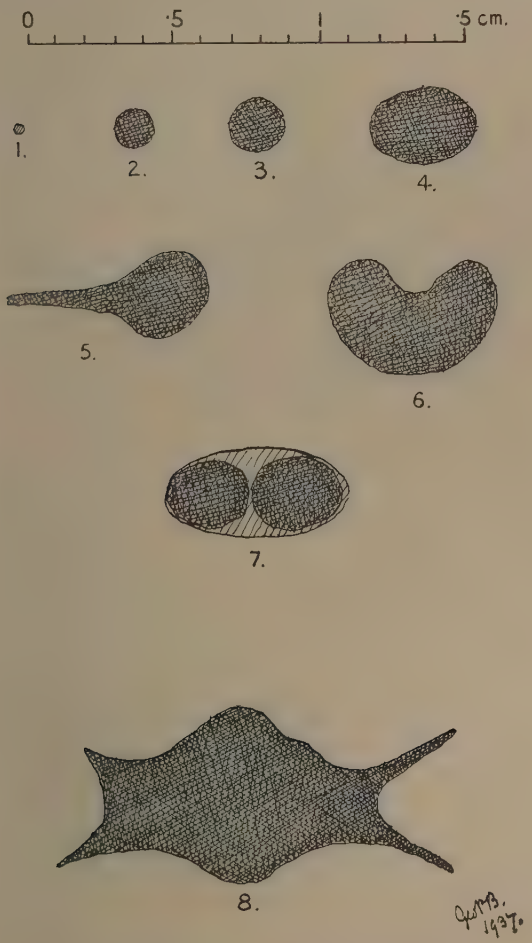

Fig. 10.—Vents of *Leuconia* of various sizes.

while with the width one-quarter or one-third of the length, the vent must be elliptical or deformed for any sponge over 3 cm.

long. These irregular outlines of the vents of the rarer large *Leuconia*, when contrasted with the tens of thousands of beautifully perfect circles in their smaller brethren, can only be explained by the forcible deformation of their strong walls through Parker's reaction to reduce the big circles of their vents to the area which will give the sponge a healthy jet*.

We have no reason to suppose that cells contractile with Parker's reaction are confined to the neighbourhood of the vent; I believe that all the canal-system, except the flagellate chambers, is lined with such cells, which maintain the growing tubes in viable proportions. The water from a flagellate chamber is led away through an efferent canal; if now the flagellate chamber divides into two there will be twice the quantity of water. With the more rapid current through the efferent canal the cells lining it relax until its transverse area is doubled. We compared a sponge to a town—it is a growing town, and the sewers and water-mains of a 3 cm. sponge are wholly inadequate for the crowded thicknesses of a 17 cm. sponge; but no borough engineer has yet discovered the expanding sewer with which our anarchist sponge meets the problem of growth so smoothly.

Contractile diaphragms are widespread in sponges. Haeckel (1872, iii, pl. 25, fig. 2) figured for 'Leucyssa' the 'gastral ostium', which guards the mouth of each flagellate chamber in *Leuconia* †. Minchin (1892) described a delicate net across the vent of *Clathrina coriacea*; he found it with two layers of cells, and he made (1892 *b*, before Parker's work on *Stylotella*) his important discovery of the closure by a sphincter diaphragm of the vents of *Clathrina clathrus* in still water, so tightly that we had all called the sponge 'lipostomous'! In this genus he considered the external flat epithelium 'the contractile or neuro-muscular layer of the sponge' (1897, p. 280). In siliceous sponges,—we have spoken of *Stylotella*,—there are elaborate sphinctral mechanisms described in *Tetractinellida*, and the first piece of research I ever attempted was to draw several times a day a young *Hymeniacidon sanguinea* (?), 7 to 10 days after fixation of the larva, which puzzled me greatly by showing a sheet of cells covering vents from which streams had been previously observed; I observed also the covering withdrawn in response to squirting the surface with a pipette.

* An additional reason for this may be that, in the larger sponge, lateral branches draw from the cloaca an increasing proportion of the water. Thus a sponge 3 cm. long may have no branch at all, but a sponge 17 cm. long may expel its water not only through its terminal vent, but through as large a total area in the vents of its branches.

† Cf. Dendy, 1893, p. 168.

A delicate lace-like tubular siliceous sponge, *Haliclona* sp. *, was cylindrical when collected (about a cm. high), but some specimens left accidentally in an unaerated basin were found to have closed the vent into a point like a paint-brush (figs. 11 & 12, *a*). This closure was effected not only by sphincters but primarily by the flexure of the few ' principal ' longitudinal fibres of spicules cemented by spongin (fig. 13, *b*), under each of which is a fibre of fusiform, granular, nucleated cells (fig. 12, *a*) †.

The structure suggests that these are cells which, in the distal fourth of the length of the sponge, contract when the current in the cloaca stops (in this case from the poisoning by stagnant water), the constriction being effected by longi-

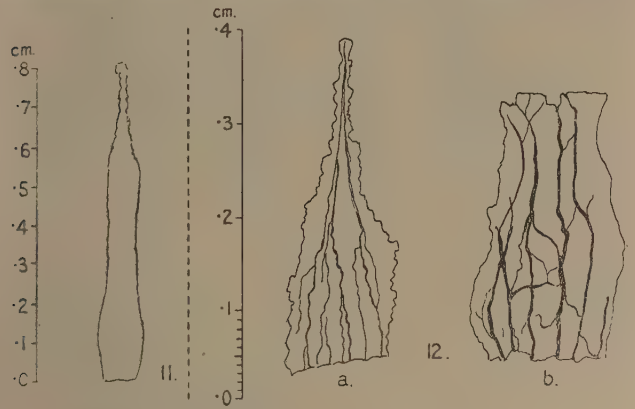

Fig. 11.—*Haliclona pygmaea* (sp. ?).
Fig. 12.—Musculo-skeletal bands of *Haliclona*.

tudinal and spiral cells, and by bending a skeletal rod to which the fusiform cells are applied like a flexor muscle to the skeleton of a metazoan. But the ' muscle ' is composed of separate fusiform cells; there is nothing to indicate any

* On a stone from Millbay Channel (probably 20 fathoms), Dec. 10, 1895, several erect white semitransparent sponges, being noticeable for the delicate lace-work their skeleton showed to the naked eye. Exactly like Minchin's text-figure of *Pachychalina* (Lankester's ' Treatise ', pt. ii, fig. 92 B). Width of principal fibres 57 μ, width of spicules in net or fibre 3–4 μ to 4·8 μ, length of spicules in net about 110 μ, in fibre 120 μ.

† Ridley and Dendy (1887, p. xxii, pls. 49 & 50) describe and figure similar parallel fusiform cells with similar granules, in *Esperiopsis*, *Acanthella*, and *Raspailia* (where they sheathe the horny axis of the sponge). They suggest that these cells secrete spongin—a hypothesis supported by the stained granules, but difficult to reconcile with their uniform distribution, or with the irrelevance of the cell-shape to any neighbouring need for spongin.

connection or any innervation, or that they act otherwise than by response to the cessation of current flowing over them. In the basal three-fourths of the sponge, the muscles, in continuous tonic contraction, would serve as tension members to the vertical and spiral girders which stiffen the hollow cylinder.

Parker's reaction provides a powerful jet for such a sponge in still water, but for surf-sponges a powerful jet is only useful if they grow outside their original environment. In *Grantia*

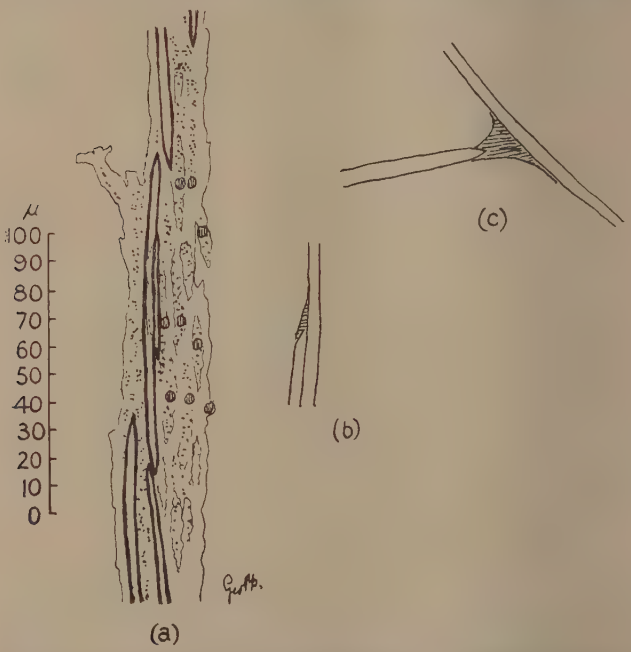

Fig. 13.—*a*. Muscle-band below spicule-band. *b*. Spongin cementing spicules of band. *c*. Spongin cementing spicules of network.

the important business of the contractile mechanism is to make an air-tight closure of the vent when the tide leaves the sponge exposed to the air, in *Stylotella* the cloaca is protected from falling suspended matter; in either case the sponge is enabled to inhabit an environment which would be impossible for a species with unregulated vent.

In *Stylotella* at Woods Hole the observed pressure maintained by the flagella is far higher than in *Leuconia* in the cooler Mediterranean; apart from temperature there is evidence that the flagella are more powerful, and the same may be held to be

true of the bath sponge. A certain line of calculation suggests that the jet from a bath sponge will be at the velocity of 10 or 15 cm. instead of the 3 cm. of *Leuconia* at 14° C. A bath sponge a foot in diameter would contain many hundreds of times as many flagellate cells as the *Leuconia*, and to carry off the water, even at that high velocity, would need a vent 3 or 4 cm. in diameter. But physicists tell us that at 10 cm. a jet would become turbulent, and therefore encounter more resistance, if its diameter exceeded 1·6 cm. for 15° C. or 1·1 cm. for 30° C. That is why our bath sponge, instead of one large round hole, has several round holes up to 1·4 cm. wide (or if we deduct for the missing tissue, say 1·3 cm. in life) for the largest diameter of the vent.

The whole evidence justifies the belief that sponges are very perfectly organized to obtain the maximum amount of food possible with the power of their flagella, and particularly, in sponges which are not stalked, cup-shaped, or fan-shaped, which have to rely on the ejecting force of their own currents to remove used water, that the mean diameter of the vent does not differ by 5 per cent. from the diameter necessary to send the efferent jet to the greatest distance possible with that flagellar pressure and that number of flagella.

The extraordinary perfection of organization without centralization in these Parazoa (or Protistan colonies) cannot be properly appraised without regarding their embryology. We will here consider one example—the well-known amphiblastula larva, which gives strong evidence of a common descent in *Leuconia*, *Grantia*, *Sycon*, and *Leucosolenia* (sensu stricto), while distinguishing them from the Clathrinidæ.

The 4-inch *Leuconia*, A.11, would produce some 5 million larvae, of which on the average one or two would survive to sexual maturity. This elimination to the millionth ensures that of young sponges, side by side, the strongest shall smother the others; but, as with the majority of animals, most certainly that only something approaching the fittest *larval* form shall survive a long succession of such eliminations. While we generally think of the larval form as a mere episode in the early history of the adult, a little reflection shows that, numerically, this world is populated by larval forms with an infinitesimal minority of adults. Belonging, as we do, to a class of animals which nurses and protects its young and to a group of our species which now rears to maturity nine-tenths of the babies born, we are apt to forget that in most phyla and classes the struggle for existence against external enemies and fraternal rivals is carried on mainly by larvæ.

The larva of *Leuconia* and *Sycon* is consequently very

beautifully and perfectly adapted for its day of swimming life (fig. 14). Its flagellate cells are arranged like the compound eye of a lobster, looking upwards. Minchin, in a paper read to the Royal Society in 1896*, described a larva of *Leucosolenia* (sensu stricto) in which the resemblance is heightened by the presence of a black pigment in the position of a retinal pigment at the bases of the lateral flagellate cells and a lens-like body in the segmentation cavity †. 'The whole

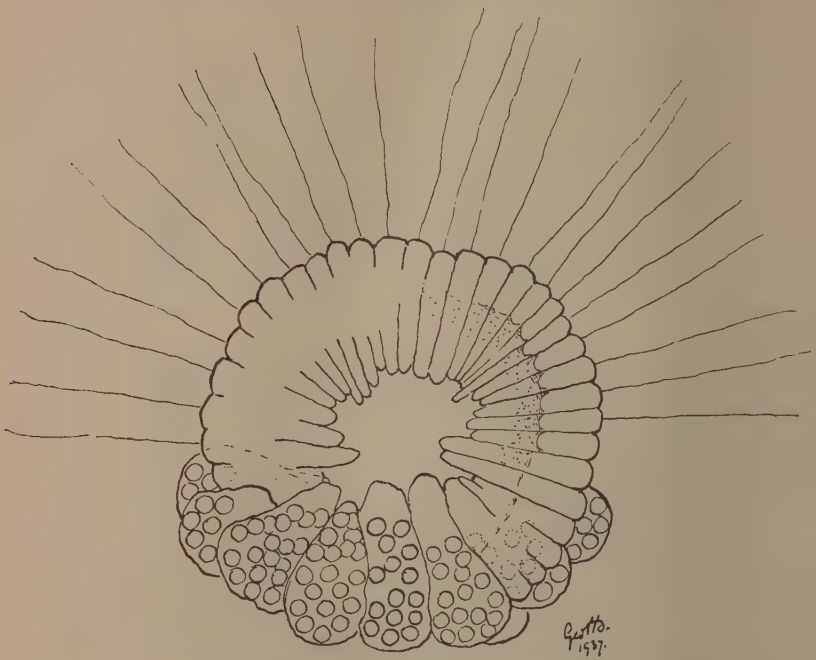

Fig. 14.—Living amphiblastula of *Sycon*, × about 800.

structure', he wrote, 'with pigment, lens-like body, and central granular cells, gives strongly the impression of a primitive light-perceiving organ'. I believe that there is no illusion in the resemblance except as concerns the word 'perceiving'; and it must be noted that the 'central granular cells' (afterwards called by Minchin 'archæocytes' ‡) were

* Minchin, 1896, p. 42.

† In the living larva drawn in fig. 14, the segmentation cavity contained a transparent fluid coloured a full vandyke-brown.

‡ Minchin, 1900, p. 75, diagram 3.

not present in the *Sycon* amphiblastula of fig. 14, drawn with special examination of that point. Being constructed like a compound eye, this *Sycon* larva must behave optically as does a compound eye. When it is swimming upward, the light will be focussed on the posterior naked patch of rounded cells, but if it tilts sideways the light is focussed on the bases of the flagellate cells of the lower side—they are consequently stimulated to more violent action and row that side up again until the focus returns to the non-flagellate cells. Consequently, the larva swims continuously upward, and, because the speed of the tidal current increases with its distance from the bottom, this leads to wider dispersal and increased chance of settling on a piece of bare stone or shell.

As larval life proceeds, Minchin has described how the lower rings of flagellate cells successively lose their flagella and become granular cells ; when this denudation has reached the equator, the steering action which I have described would cease, because the larva turning out of the perpendicular presents a broken lens to the light and because the rowing cells on which it should act are metamorphosed. But if there is no dominant lenticular focussing of transmitted light, the action of the light falling directly on the outer surfaces of the flagellate cells will have the converse steering effect : the upturned side will receive more light and will therefore beat more strongly and become more upturned until the larva is inverted. No lens action taking place through the rounded granular cells, the directly falling light will rouse to action any upturning cells until they beat their way back into shadow, so the larva will be steered vertically downwards until it touches bottom, flagella first. The hypothesis was suggested by the fact, already mentioned, that in living collar-cells I have seen motionless flagella started into action by being brought into the bright spot of light in the centre of the microscope field.

The larva of *Sycon*, *Leuconia*, and *Leucosolenia* (sensu stricto), is therefore a true eye, but it is not an organ of vision. It is an eye through which nothing sees. The light focussed by it starts into action the cell on which it falls—again, " the receptor is also the effector " *.

Naturally, we picture the new-born larva, swimming through the sun-lit blue water towards the light it loves, for one happy day before it settles down to drab adult life fixed to the rock, in the shadow among the weeds and the slimes. Actually there is no perception of the light that guides its course, no

* It seems possible that the phototropy of other larvae may be due to a less perfect similar lenticular action, and that this accounts for the common bare patch behind, ensuring that while the larva swims toward the light the focussed rays can stimulate no flagellum and the direction of progress is undisturbed.

knowledge of freedom or fixation : in that pretty wander-day the larva has no more pleasure, pain, or power of choice than a toy aeroplane, or a selenium cell which rings an alarm-bell when its ray of light is taken from it. Therefore we need not grieve over the thousand billion *Leuconia* larvae born each summer to be devoured alive, more than we need grieve over the continuous dissociation of molecules in the air around us. Theirs is a simulation of joy, intelligence, and tragedy ; but it is true life. A living thing differs from a non-living thing in that its parts are so disposed that they carry out motions which conduce to the continued existence of the whole, including offspring not yet apparent.

For the adult sponge it is a matter of our idiosyncrasy whether we ascribe the wanderings and greediness of the ovum, with the behaviour toward it of collar-cells and spermatozoa, to emotion or to chemiotaxis. For a congeries of such units, some have suggested that there may be a mind in a hive of bees : but the bees of a hive communicate with each other—there can be no more mind or consciousness in a sponge than in a sack of potatoes. The only communication between the flagellate cells and the contractile cells of the vent is by means of the current of water. When, through low temperature or poison, the flagellate cells are sluggish, the slower movement of the water in the vent does not tickle the contractile cells enough to keep them relaxed. They shorten and contract the vent until the jet is speeded enough to titillate them to the degree necessary, at that curvature, to lull them from further shortening. There is no reverse message from vent to flagellate cells ; complete closure of the vent raises the pressure in the flagellate chambers by less than $1/10^8$, though it raises the pressure in canals and cloaca to equal that of the chambers. The flagellate cells receive no message and need none, they always continuously work their hardest and there is nothing more or less to be done about it.

Man's body, to a certain extent, is a congeries of independent organisms. Our phagocytes save our lives by their heroically suicidal greed, they hunt and catch their prey in movements as independent of us as those of foxes catching rabbits in the next county ; only that our nervous system can stir them to greater or less effort by pouring into the serum hormones to excite or opsonins to appetize them. In the conduct of the hunt the blood corpuscle is as independent a command as the predatory ovum of the sponge, and our existence depends on his personal efficiency.

It is impossible to avoid consideration of the degree of analogy between the sponge and an aggregate of men, such as a nation. Though men have much communication with each other it is very imperfect, and legislation at Westminster is not guided by Burlington House : a nation, as a rule, is

governed, not by a brain, but by a lumbar plexus. The most essential difference between a nation and a sponge, justly deplored by dictators and soviets, is imperfection of specialization; no man is so single in intention as the sponge-cell. It is only recently that man has been united in nations of numbers comparable to the number of cells in a very small sponge: most of our ancestral history lies in family aggregates, where every man was prepared to do every duty. Therefore, though nature has designated many of us to be searchers, makers, or fighters, in most the inheritance is mosaic: so we have traders who are horticulturists or zoologists, philosophers who are prime ministers, soldiers who are mathematicians and biologists who are pugnacious—such imperfections are bad for the state, and make existence delightful.

In this Society we are in the first place searchers, and I think we shall agree that we have this in common with the sponge's flagellate cells—that we must go on. Surpassingly great is the pleasure of scientific discovery, but I do not believe that we make research for the sake of that pleasure, though we may think so. I think we are obliged to do it, like a flagellum waving. It is a consolation for seekers after truth to see for a moment the perfection of a sponge, and to believe that even in this haphazard collection of ego-centric units which is humanity, if we, each in our unregarded corner, go on working without pause, without praise, and without end, the sum of it all is for the good of the community.

Further explanation of text-figures.

Fig. 1.—Compounded drawing of living flagellate cells in *Leuconia aspera*, with arrows indicating the direction of movement of the water. (From Bidder, 1923, text-fig. 8.)

Fig. 2.—Sketch of a living collar-cell of *Grantia compressa*, with flagellum vibrating perhaps four times a second; its two limiting positions are shown. Three successive positions of a coccus are recorded, showing it driven (against a current) in a straight line away from the cell.

Fig. 3.—Living diaphragm of *Leuconia aspera* in maximum contraction, seen at the bottom of the crown of spicules, which surrounds the vent. The sponge had been cut through, about 1 cm. below the diaphragm, so that perhaps 1/500th of the pre-existing stream now passed through the vent.

Fig. 4.—Hair-spicules of *Grantia compressa* with, on three spicules, the pairs of cells ('adelphidia') which form them. The preparation was critically stained with eosin and methyl-blue, the nuclei are basiphil, the cells pink with very minute eosinophil granules. Cf. Bidder, 1898, p. 62, footnote:—

"*Sycon compressum*" [Dendy's name, 1893, for *Grantia compressa*] "has hair-spicules about 1/10 μ in thickness which are each formed by two cells, as Minchin describes for a ray of a triradiate in *Clathrina*; and the young giant club-spicules also show two formative cells. For such pairs of cells I suggest the name 'adelphidia'; they were described by Lendenfeld and Stewart as sense-cells."

(Cf. Woodland, 1905, pl. 13, figs. 10–12; Minchin, 1908, fig. 42.)

Fig. 5.—Young club-spicule of *Grantia compressa*, showing the pair of cells which are forming it. (See above, and Woodland, pl. 14, fig. 41 ; Minchin, fig. 84.)

Fig. 6.—Live ovum sketched on the chamber (sea-water) surface of collar-cells of *Grantia compressa*. The streak of black dots represent bright green fragments of a broken chlorophyll grain, which were conspicuous in the protoplasm of the ovum. (The condenser diaphragm was widely open to show colour, so that collars were invisible.)

Fig. 7.—Ovum of *Grantia compressa* in the chamber, supported on the converging collars of collar-cells. The flagella had ceased to move, so that the contours were altered from those of healthy life, the collars and distal parts of collar-cells being constricted and elongated.

Fig. 8.—Collar-cells of *Clathrina coriacea* at Naples, overlaid by the thin laminal extension of an intrusive dermal cell (not indicated in the drawing), through which the cells are focussed.

Fig. 9.—One method of measuring approximately the velocity of jet from the vent of a sponge (' A.57 ' Naples, April 1932).

Fig. 10.—Outlines of the vents in the specimens of *Leuconia aspera* on which the principal experiments were made, drawn to one scale, showing increasing departure from the circular with increasing size.

(1) Very young sponge. (2) Branch of A.45, membrane imperforate. (3) A.11. (4) A.49. (5) A.50. (6) A.57. (7) A.52. (8) A.53.

(Figs. 11, 12, 13 are of *Haliclona pygmaea* Bk. (sp. ?).)

Fig. 11.—Reconstructed outline of the sponge in stagnant water.

(The sponge was ' preserved 90 per cent. alcohol, stained borax carmine, and mounted Canada balsam in four pieces '.)

Fig. 12.—Main musculo-spicular bands, stained deeply with borax-carmine.

(*a*) Distal part of sponge (fig. 11), mounted whole, the extreme right and left bands belonging to the farther wall.

(*b*) Portion of the wall cut from the cylindrical part of the sponge immediately below (*a*).

Fig. 13.—(*a*) Musculo-spicular band, showing spicules at the higher focus lying on the stained muscle. The granules and nuclei are, about equally, more deeply stained.

(*b*) Two of the spicules of the band united firmly by clear faintly staining spongin (diagrammatically shaded).

(*c*) Two spicules of the dermal reticulation, external to the musculo-spicular bands. They are united by a hinge of spongin, which allows the network to wrinkle when the sponge contracts.

Fig. 14.—Living larva of *Sycon raphanus* in optical section.

Gatenby's figures (1920, pl. 23), of the amphiblastula of *Grantia* in stained section, suggest that the lens of each flagellate cell in this drawing includes the nucleus ; possibly the convex inferior surface of the lens is the actual surface of the nucleus. His granules ' O G ' may be represented by a fine shadow recorded in life (in *Sycon*) under the corneal surface of the lens, too faint for representation in line. The lens is separated from the water by a firm profile, but no corneal cuticle could be detected.

Conceivably the structure arose through the nucleus being slightly more refractile than the protoplasm (as it often becomes in a living collar-cell after some time on the slide. Cf. Bidder, 1895, p. 2, fig. 9, *a*). Its lenticular action proving advantageous, the refrangibility was perpetuated and the structure between nucleus and water became modified to an equal refractive index, so that the light enters a ' Coddington ' lens from the water.

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Postscript.—Germ-cells and amoeboid cells.

It would lead us too far to attempt to discuss the significance of Minchin's amoeboid cells with refringent and those with fine granules (1897, p. 498), of the observations of Dendy and Gatenby on phagocytes, nurse-cells, and cellular inclusions, or the numerous categories of amoeboid cells recognized by some modern authors*. I believe that in *Calcarea* all amoeboid cells wandering in the mesogloea are potential ova, but brief dogmatic statement about them is clearly not justified.

In *Grantia* they resemble the young ova in size and appearance, like them they feed on the basiphil reserve-granules of the collar-cells, they possess similar acidophil granules; but (when killed in corrosive sublimate) instead of large unstaining ovoid vesicular nucleus, with a weakly staining nucleolus, they show a spherical nucleus, perhaps $3\frac{1}{4}\mu$ in diameter as compared with 3μ in the collar-cell, with a strongly basiphil chromatin reticulum. The reticulum has a coarser thread and is more basiphil than in the collar-cell; its appearance is well shown by Jörgensen (1910), Taf. xi, fig. 1.

Amoeboid cells differ in appearance from spicule-cells only in the absence of a spicule, and of the fusiform or stellate extension of the cell on the spicule's surface. They are not confined to the choanosome, but are frequent in the cortex; the columnar or mushroom cells which clothe the outer surface seem different only in shape—necessarily influenced by the external exposure of part of the cell's surface.

The eosin–methyl-blue preparations make very acceptable Jörgensen's conclusion (l.c., p. 171):—that there exists no essential difference between 'mesoderm cells' on the one side and wandering cells or egg-cells on the other side, and that mesoderm cells can change into egg-cells. And to the opinions that he quotes from Minchin (1898, 1908) and Maas (1899), that spicule cells and epithelial cells are interchangeable, I would add my provisional belief that wandering cells and spicule-cells are brothers of temporarily different occupations. In fig. 4 the spicule-cell on the right hand shows a nucleus in the vesicular state antecedent to division (cf. Jörgensen, Taf. xi, figs. 3 & 5); the result of such division would be

* Summarized by Webb (1935).

an amoeboid cell attached to the lower spicule-cell, and such a group appears in other drawings of these preparations. On present evidence it would seem that the new cell so formed may wander off as an amoeboid cell or at once divide in two to form a new spicule. The connection between two pairs of spicule-cells on the left of the drawing suggests that the cells of the shorter spicule are daughters of the distal cell of the longer spicule (cf. Woodland), the frequency of wandering amoeboid cells in this (cortical) neighbourhood suggests that sometimes the daughter-cell becomes detached as a wandering amoeboid cell.

Minchin describes the origin of spicule cells from ' ectoderm ' cells, Minchin and Woodland the origin of spicule-cells from spicule-cells. Minchin (1897, p. 512) infers the wandering away of spicule-cells into the mesogloea, though he considers they would present a very different appearance from that of the wandering amoeboid cells. Gatenby describes and figures the transformation of an amoeboid cell into an ovum.

Julian Huxley (1911), experimenting on reconstructed sponges, found that an aggregate of only collar-cells was incapable of forming any spicules or dermal tissue. This, like the experimental embryology of Maas, supported the opinion then suggested by many facts in the histology of sponges—that a sponge consists of specialized collar-cells and protean dermal cells. This again seems supported when it appears at first that the only basiphil granules in the whole sponge are found in every collar-cell ; though further examination shows that the pylocytes of the chambers are also basiphil.

On the other hand, in the past eighty years there has been only confirmation of Lieberkühn's classic observation, in freshwater sponges, of the metamorphosis of flagellate chambers in deleterious conditions. In (1933) paragraphs 2 to 5, I recapitulated Weltner's observations on *Ephydatia*, Metschnikoff's on *Halisarca*, my own on *Grantia* (1895, p. 27), Minchin's, Urban's, Dendy's, and my own on *Clathrina* (cf. fig. 8), claiming Burton's observations (1933) of *Tenacia* and other preserved sponges showing no flagellate chambers, as also due to the same phenomenon :—the collapse of the chambers when poisoned or frozen (owing to the flagella no longer producing a distending pressure), the loss of flagella and collars, and the conversion of the collar-cells into some kind of amoeboid cells. To weigh against the experiments of Huxley and Maas, Dendy (1914) and Gatenby (1920) each satisfied himself that he had proved the metamorphosis of collar-cells into amoeboid cells and ova (note that Huxley's collar-cell aggregates showed no spicule-cells, but they did show ova). Gatenby follows Jörgensen in (rightly) condemning the assumption that all reproductive cells must be derived from a Weismann germ-plasm segregated in early ontogeny.

I believe that Minchin's archaeocytes in the segmentation cavity of Calcaronea show no all-important separation of generalized from specialized cells, but sometimes occur and sometimes are not present according to casual incidents during the cell-division. I know of no evidence to show that any sponge-cell has lost its power of becoming a reproductive cell, nor any *a priori* reasoning to indicate that in Parazoa we should expect the possibility of metamorphosis into an ovum to be restricted to a single category of cells.

Mr. W. S. Rowntree, Sir Peter C. Mitchell, Prof. E. S. Goodrich, and the President commented on the paper.

The Cambridge Botanical Expedition to Nigeria: studies in the ecology of the tropical rain-forest. By Dr. P. W. Richards, F.L.S., Mr. R. Ross, and Mr. G. C. Evans. [Abstracts.]

Dr. P. W. Richards: The chief object of the Expedition was to make a detailed comparison of a typical area in the African rain-forest with areas previously studied in British Guiana and Sarawak. The Expedition was in Nigeria from January to June 1935; the greater part of the time was spent at a base camp in the Shasha Forest Reserve, Ijebu Province, some 70 miles east of Lagos, but a short visit was made to the Okomu Reserve in Benin Province, about 70 miles farther east.

A series of lantern-slides was shown illustrating various aspects of the Expedition's work. The stratification of the primary forest was demonstrated by means of profile diagrams drawn to scale from data provided by clear-felling plots. The floristic composition of the forest was studied by enumerations of the trees on sample plots. A table was shown comparing the results with those for a similar plot in the Mixed forest of British Guiana.

The Nigerian forest showed a general similarity in structure to that of British Guiana and Sarawak, but there were some differences—possibly due to the fact that the areas studied were only just within the climatic limits of rain-forest. The most striking difference between the Nigerian forest and that of Guiana and Sarawak was the comparatively small number of species of trees: this is probably unconnected with the local climate and is a general feature of the African rain-forest.

Mr. G. C. Evans spoke on the atmospheric environmental conditions near the ground observed in the tropical rain-forest.

The atmospheric carbon dioxide concentration, contrary to a widely held opinion, did not exceed twice the normal. Its maximum was in the early morning, and it fell to about 30 per cent. above normal in the forenoon. Changes in air-temperature were small, and unlikely to have major effects

on plant-life. Although the absolute humidity may remain fairly constant at different times of the day and in different seasons, changes of temperature result in large changes of saturation-deficit, up to a maximum of 10–12 mm. in the early afternoon in the dry season.

Mr. R. Ross said that the work on which he was engaged during the expedition was an investigation of the course of the secondary succession following on the abandonment of cultivated land.

The cultivation is of the shifting type. The natives clear an area of forest, chopping down all but the largest and hardest of the trees, burn it over, and then grow a variety of crops on it. After two or three years the ground becomes unprofitable and is abandoned.

The succession following on this was studied by means of sample-plots in areas of various ages. These plots could only be 200 by 100 feet, which was unsatisfactorily small. Larger homogeneous areas, however, were not present. The plants taking part in the succession are of three types—weeds of cultivated land, which play a minor part in the early stages only, plants of secondary habitats, and plants characteristic of high forest. In the first two or three years the most prominent species are *Vernonia conferta* Benth., *Vernonia frondosa* Oliv. & Hiern, and *Trema guineensis* (Schumach.) Ficalho. These are very rapid-growing soft-wooded species which, in this time, reach a height of 12 to 15 feet. At about three years *Musanga Smithii* R. Br. assumes dominance. This is apparently unable to colonize bare ground and seems to require for germination the protection of a cover of vegetation. On the first sample-plot studied, where the vegetation was five years old, it was forming an almost closed canopy 35 to 40 feet from the ground.

On this sample-plot there were already many species characteristic of primary forest represented, but by very few individuals over two inches in diameter, which was the size-limit below which individuals were not separately recorded. The next sample-plot was fourteen years old. Here the canopy of *Musanga Smithii* R. Br. was 70 feet or slightly more from the ground. Below this there was a definite layer of shrubs at about 15 feet, and between these two layers young individuals of various tall trees. On this plot the proportion of species characteristic of primary forest had increased, and these were equal in individuals and species to those characteristic of secondary habitats.

On the third plot, which was seventeen years old, a great change had taken place. Most of the Musanga trees had died and disappeared. Death usually occurs in this species at about fifteen years and appears to be due to senescence, as no

pathological symptoms were seen. On this plot the proportion of primary-forest species has again increased and the total number of such species present is equal to the number over four inches in diameter on a plot eight times the size in primary forest studied by Dr. RICHARDS. It therefore appears that primary forest is being regenerated in the area studied. This, however, is a forest reserve where much uncleared forest remains. In areas where cultivation has been more extensive and no areas have remained uncleared such regeneration does not normally take place.

Mr. K. BISWAS (Visitor) confirmed Dr. Richard's classification of the rain-forest into three storeys. But the primeval rain-forest in Tenasserim, South Burma, along the borders of Siam and British Burma exhibits four—if not five storeys. First, the top canopy of the tallest trees chiefly of *Ficus*, *Dillenia*, *Dipterocarpus*, *Stereospermum*, and other species; secondly, the next lower zone of *Bamboo brakes* interlaced with *Calamus* (rattan canes), and mixed with medium-sized trees and the tallest shrubs; thirdly, the relatively tall herbaceous mixed association in which often Scitaminaceous species are predominant. This herbaceous association is often interspersed with groups of ferns, grasses, cycads, and palms with dominant *Licuala* species; fourthly, a carpet layer of mixed association of trailing herbs composed of *Elatostema* sp., *Piper* spp., Selaginellas, dwarfed ferns, and Araceous species. The leaves of some of these trailers are variegated with multi-coloured spots—commonly known as 'leaf-mosaic'. This layer of vegetation on the forest-floor is dependent mainly on the amount of light penetrating through the canopy overhead, moisture, and amount of food available in the soil. Many tiny herbs composing the floor-vegetation grow up quickly, flower, fruit, and die within a short time. Such vegetation of what may be called 'Ephemerals' is generally abundant during the early part of the rains, when some of the deciduous taller members allow sufficient light and moisture for the delicate crops of the forest-floor to play their brief rôle of life-cycle.

As regards secondary growth Mr. Ross mentions that from the study of the secondary formation one can have some idea of the original forest. This is true as far as the general rhythm of growth is displayed in the growing associes. But in a primeval forest there exist many seeds of other species which can hardly get chances of displaying themselves in the struggle for existence. It has often been observed that these species which have been lying dormant for years grow up vigorously as soon as they get the chance of establishing their association in the secondary formation after felling of a primeval forest. Thus the composition of species in the secondary formation

is likely to be changed. Rotation of several species is expected in secondary or tertiary growth. Some species of the original association may disappear altogether for some years. The chart of specific composition is therefore subject to considerable variation in secondary formation of a rain-forest.

Mr. I. H. Burkill said that he was glad Dr. Richards recognized layers in the vegetation composing the forest. He added that in his opinion three should be expected in all virgin forest. The top of these consists of the tallest trees of the locality and owes its distinctness to their persistence beyond maturity—they come to full size and accumulate by remaining at it; the second is a filling layer; the third is a ground layer. To make numerous layers, as for instance Kurz did in his study of the forests of Burma, seems artificial.

6 May 1937

Dr. W. T. Calman, C.B., F.R.S., President, in the Chair

The Proceedings of the General Meeting held on Thursday, 22 April 1937, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Frederick Ronald Hayes; for the first time, in favour of Srinivasa Ramanujam.

A certificate of recommendation of the following candidate for Associateship was read for the first time :—Francis Rilstone.

The President explained that the ballot for an Associate as announced in the programme of the present Meeting had been found to be not in accordance with the Bye-Laws.

The following candidates, whose names were read for the third time, were balloted for and elected Fellows :—Hugh Victor Newby, B.Sc., Robert Haynes Jeffers, Tom Clifford Denston, B.Pharm., Ph.C., Alan Campbell Gardiner, M.A., Thomas Alan Stephenson, D.Sc., Carl Frederick Abel Pantin, Sc.D., F.R.S., and Hugh Bamford Cott, M.A., D.Sc.

The following candidates, whose names were read for the third time, were balloted for and elected Foreign Members :—Dr. Reinhard Dohrn, Prof. Herman Augustus Spoehr, Prof. Erik Andersson Stensiö, Prof. Nils Eberhard Svedelius, and Prof. Richard Woltereck.

Notes on several Indo-Pacific species of Sesarma (Crustacea Brachyura). By Dr. Isabella Gordon, D.Sc., Ph.D., F.L.S., Zoological Department, British Museum (Nat. Hist.).

Sesarma (*Sesarma*) *maculata* de Man.

1892. De Man, Weber's Zool. Ergebn. Reise niederl. Ost-Indien, ii, p. 347, pl. 21, f. 19 (*nec* 1902).
? 1917. Tesch, Zool. Meded. Leiden, iii, p. 170.
1934. Balss, Zool. Anz. Leipzig. cvi, p. 180.

Remarks.—Two male and two female specimens of this species from the British Solomon Islands, collected by R. A.

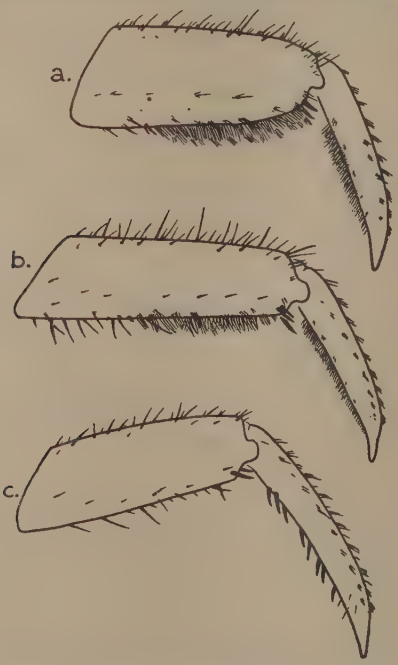

Fig. 1 *a–c.*—*Sesarma maculata* de Man, 1892 *nec* 1902, ♂ (*c.l.* = 15 mm.). Propodus and dactylus of first, second, and fourth walking-leg respectively.

Lever, F.L.S., show the sexual dimorphism first described by Dr. Balss in 1934. In the male the ventral margin of the propodus and dactylus of the first walking-leg are heavily setose as represented in fig. 1 *a*. These hairy patches are also present on the second leg, but they are less pronounced

(fig. 1 *b*). In the larger male (*l.* of carapace=15 mm.) there are a few traces of short setae on the ventral margin of the third dactylus which is also beset with 6–7 short dark brown spines. The ventral margin of the fourth dactylus bears spines only (fig. 1 *c*). These dark brown brush-like patches of setae, so

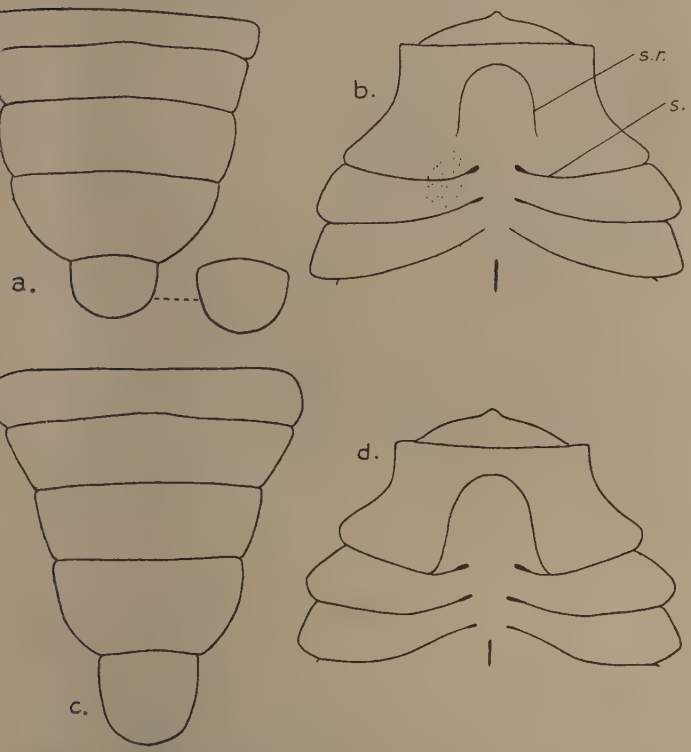

Fig. 2.—'*Sesarma maculata*' de Man, 1902 *nec* 1892. *a*. Segments 3–7 of male abdomen (*c.l.*=13 mm.). *b*. Diagram of anterior portion of sternal plate of male, showing the ridge that bounds the 7th abdominal segment when flexed (*s.r.*) and three pairs of transverse grooves or sutures (*s.*). *Sesarma maculata* de Man, 1892 *nec* 1902. *c*. Segments 3–7 of male abdomen (*c.l.*= 15 mm.). *d*. Diagram of anterior portion of the sternal plate of male.

conspicuous in the male, are absent in the female, and all the legs are beset with sparse dark brown bristles, some of which are rather spinose.

Wishing to confirm my determination, I sent to the Leiden Museum for the loan of a male specimen of *S. maculata* determined by de Man. The specimen from Ternate that I received shows no trace of hairy patches on the two anterior pairs of legs, and differs in other respects from the males from the Solomon Islands. The abdomen is less triangular (*cf.* fig. 2 *a* & *c*); the median depression in the sternal plate *, over

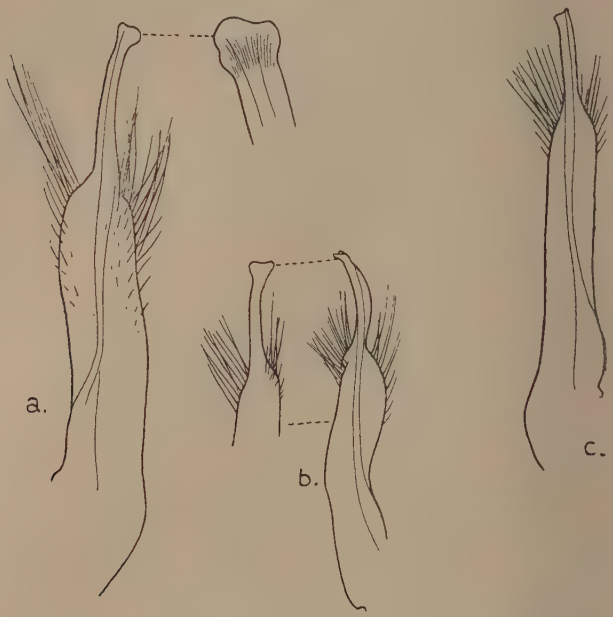

Fig. 3.—*Sesarma maculata* de Man, 1892. *a*. First pleopod of larger male from British Solomon Islands from sternal (or concave) side, with apex more highly magnified. *b*. Same of smaller male, with another view of the apex. '*Sesarma maculata*' de Man, 1902 *nec* 1892. *c*. First pleopod of male, from sternal side.

which the abdomen folds, is much shallower and the sternal arch (marked by a ridge), which embraces the seventh abdominal segment, terminates, or fades out, some distance in front of the anterior pair of sternal grooves or sutures (fig. 2 *b*). In the specimens from the Solomon Islands, on the other hand,

* For shortness, the 'post-oral cephalothoracic sterna', which are fused to form a single plate, are referred to as the 'sternal plate'.

the ridge of the sternal arch is continued posteriorly to meet, or almost meet, the anterior pair of sternal sutures (fig. 2 *d*). The first pleopods are rather similar in both, as illustrated in fig. 3 *a–c*.

Mr. Tweedie, who kindly examined the type-material of *S. maculata* in the Amsterdam Museum, wrote to me as follows : '(1) The arch of the sternal depression, in front of the first sternal suture, is marked by a ridge, depressed below the level of the sternum, which is distinct right up to its contact, on each side, with the suture. (2) The hairy tufts are present on the propodi and dactyli of the first two pairs of walking-legs, but much more distinct on the first, which is just as you have drawn it in the upper figure [sketch of fig. 1 *a*]. The rest of the legs carry only stiff, widely spaced setae.'

It is thus clear that the specimens determined by Balss (1934) and the present specimens from the Solomon Islands are conspecific with the types of *S. maculata*. The male specimen from Ternate (Kükenthal, 1893/4, Cat. no. 1205) now in the Leiden Museum, although determined by de Man (1902, Abh. Senckenb. Ges., Frankfurt a. M. xxv, 3, p. 517) does not belong to *S. maculata*, but to some other species. Perhaps this also applies to all the specimens that de Man had before him in the Kükenthal collection, and, in that case, the differences between these and the type-material of *S. maculata*, mentioned in de Man's later description (1902) would be explained. It may well be, also, that Tesch based his *S. maculata* characters (1917, p. 246, in key, and p. 170) largely on the specimens from Ternate, determined erroneously by de Man. Until all the material referred by various authors to *S. maculata* has been re-examined it is not possible to decide which specimens actually belong to the species. The known distribution is as follows :—Flores (type-locality), Amboina, Taroena, and British Solomon Islands.

Specimens of the following two species, which are closely related to *S. maculata* (according to Tesch's key, 1917, pp. 245–246), were also obtained on loan from Leiden Museum :—

Sesarma (*Sesarma*) *ocypoda* Nobili
subsp. *gracillima* de Man.

1902. De Man, Abh. Senckenb. Ges., Frankfurt a. M. xxv, 3, p. 522, pl. 19, f. 9.
1917. Tesch, Zool. Meded., Leiden, iii, pp. 179–182, pl. xvii, f. 1.

Remarks.—The male received for examination (Cat. no. 1954, Natoena Islands) is one of those described at some length by Tesch, and the determination was confirmed by de Man.

The first pleopod is almost triangular in cross-section, and is quite distinct from that of *S. maculata* ; as it has never

been figured, camera-lucida sketches were made from three different aspects—abdominal, sternal, and median (fig. 4). The median sternal depression is deep and the ridge of the

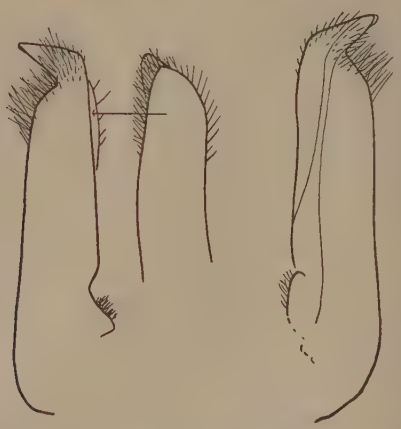

Fig. 4.—*Sesarma ocypoda* Nobili, subsp. *gracillima* de Man. First pleopod of male, from three different aspects (*c.l.*=13 mm.).

sternal arch, bounding the terminal abdominal segment, is continued posteriorly to meet the first sternal suture or groove on either side (as in fig. 2*d*).

Sesarma (*Sesarma*) *sylvicola* de Man.

1892. *Sesarma* (*Geosesarma*) *sylvicola* De Man, Weber's Zool. Ergebn. Reise niederl. Ost.-Indien. ii, p. 345, pl. 20, fig. 18.
1899. *Sesarma* (*Geosesarma*) *sylvicola* Nobili, Ann. Mus. Civ. st. nat., Genova, (2) xx, p. 513.
1902. *Sesarma* (*Sesarma*) *sylvicola* De Man, Abh. Senckenb. Ges., Frankfurt a. M. xxv, 3, p. 522, pl. 19, fig. 11.
1910. *Sesarma* (*Sesarma*) *sylvicola* Rathbun, Bull. Mus. Comp. Zool., Harvard, lii, p. 309.
1917. *Sesarma* (*Sesarma*) *sylvicola* Tesch, Zool. Meded., Leiden, iii, p. 200.

Remarks.—Only two of the three cotypes mentioned by de Man (1892) are now in the collection of the Amsterdam Museum. These were kindly sent on loan by Professor de Beaufort, and, on examination, *both* proved to be females. De Man described his cotypes as 'zwei Männchen und ein junges Weibchen'. The genital openings are indicated in both specimens, although they may not be perforate; in the smaller specimen (*c.l.*=5·5 mm.) the abdomen is narrow and not unlike that of the male, but the pleopods are of the female type. In all probability the third and largest cotype, that

measured by de Man (1892, p. 346), is a male, and it may have been from this specimen that de Man obtained the illustrations for pl. 19, figs. 11, 11 *a–c*, in his later paper (1902) *.

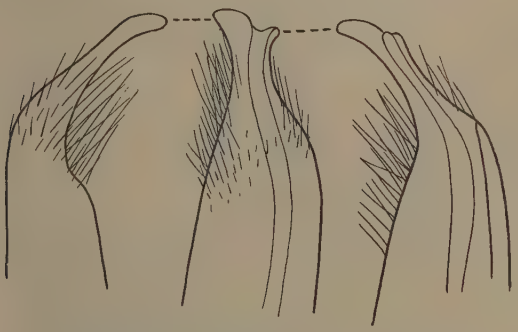

Fig. 5.—*Sesarma sylvicola* de Man, from Takfak.
Apex of first pleopod of male, from three different aspects (*c.l.* = 10 mm.).

The only male specimen of *S. sylvicola* that I have examined is one from Takfak, New Guinea, in the collection of the Leiden Museum (Cat. no. 2192). This specimen, which was determined by de Man, has the first pleopod of the type represented in fig. 5 ; the sternal depression is deep, and the arch that bounds the seventh abdominal segment, when flexed, reaches to the first sternal groove or suture on either side.

Sesarma (*Sesarma*) *gracilipes* H. Milne-Edwards.

1917. Tesch, Zool. Meded., Leiden, iii, p. 154.

Remarks.—*Sesarma schüttei* from New South Wales, determined by Miers, 1886, *Challenger* Reports, Zool. xlix, p. 271, must be removed from the synonymy of *Sesarma gracilipes* listed by Tesch. The walking-legs are not nearly as slender as in *S. gracilipes*, and the shape of the carapace and of the male abdomen is also different. The chelipeds are represented by small limb-buds and must both have been lost some time prior to the capture of the specimen.

Acknowledgments.—I have to thank Mr. R. A. Lever, Government Entomologist, Tulagi, British Solomon Islands, for presenting the specimens of *Sesarma maculata* de Man, together with other material, to the British Museum. I am also indebted to Professor L. T. de Beaufort of the Amsterdam Museum, Dr. H. Boschma of the Leiden Museum, and the

* I have been unable to trace this third specimen ; it is not in the Leiden or Senckenberg Museum Collections.

Director of the Senckenberg Museum, Frankfurt, for sending me material on loan and for replying to my enquiries relating to type-specimens. My thanks are also due to Mr. M. W. F. Tweedie, of the Raffles Museum, Singapore, who kindly examined for me the type-material of *Sesarma maculata* de Man during a short visit to the Amsterdam Museum.

The anatomy of Baccalaureus torrensis, sp. n. (Cirripedia, Ascothoracica). By Mr. K. A. Pyefinch. (Communicated by the President.) [Abstract.]

This new species of *Baccalaureus* was found within the polyps of the Zoanthid coral, *Palythoa howesi*. Externally it resembles previously described species of the genus, as the segmented body is completely enclosed within a mantle. The segmented body is attached to the median lobe of this mantle by means of a strong adductor muscle, and is of interest in showing a condition intermediate between that of *B. argalicornis* and *B. japonicus*. The known species of *Baccalaureus* can now be arranged in a rough series, showing increasing fusion of the thoracic segments and reduction in the number of the thoracic appendages. This series reads :—*Baccalaureus argalicornis*, *B. torrensis*, *B. japonicus*, *B. maldivensis*, and *B. hexapus*.

Much of the gut-epithelium is loaded with large granules. The function of these is as yet unknown. They may be excretory; or it is possible that they are nutritive. The whole problem of the source of the food of these parasites is obscure, as the segmented body is enclosed within the mantle which, in its turn, is enclosed within a layer of Zoanthid tissue.

Well developed maxillary glands are present, and there are also glandular structures in the anterior part of the body, the identity of which is uncertain. One part of these structures (situated more dorsally) may represent an antennal gland, whereas the other (situated more ventrally) more resembles the segmental gland of an Ostracod.

In reply to the President, Mr. Pyefinch agreed that the inclusion of the Ascothoracica within the Cirripedia was, in some respects, unsatisfactory, and pointed out that the increasing knowledge of the group seemed to make their position even more unsatisfactory.

The herbal of Valerius Cordus. By Dr. T. A. Sprague, F.L.S., and Miss M. S. Sprague, M.A. [Abstract.]

Dr. Sprague gave a general account of this sixteenth-century herbal, illustrated with lantern-slides of some of the more interesting plants. The descriptions were written by Valerius Cordus ; but the figures were added from Bock's herbal (1552) and other sources by Konrad Gesner.

Valerius Cordus may be regarded as the Father of Phytography, and his descriptions are in most cases so good that it is possible to determine the species from them, and occasionally even the variety. In about 43 instances the figures supplied by Gesner actually represent different species from those described by Cordus, thus complicating the work of identification.

The plants in the herbal were identified in the following way :—All references to Valerius Cordus contained in Kaspar Bauhin's ' Pinax ' were first extracted, and the corresponding names in Linnaeus's ' Species Plantarum ' were then obtained from Richter's ' Codex '. Each of the resulting provisional identifications was checked. Where a description had been misidentified or had not been identified, it was read through and compared with pictures of the species known to occur in the area concerned. Sometimes it was necessary to translate a description into English, re-arrange it, replace some of the words by modern technical terms and then compare the resulting description with figures in Reichenbach's ' Icones ' or descriptions in Hegi. In order to understand the descriptions in the herbal, glossaries had to be prepared of the botanical terms used in Pliny (1st century), Isidorus (7th century), Albertus Magnus (13th century), and Ruellius's translation of Dioscorides (1516). These have already been published.

Among indigenous plants discovered by Cordus in Germany were *Dentaria bulbifera*, *Saxifraga Aizoon*, *Euphorbia dulcis* var. *lasiocarpa*, *Oxycoccus quadripetalus*, *Menyanthes trifoliata*, *Lathraea Squamaria*, *Adoxa Moschatellina*, and *Scorzonera humilis*. *Calamintha Nepeta* var. *nepetoides* was a first record for Italy. An exotic drug identified by Cordus with Galen's *Carpesium*, a native of Syria and Asia Minor, proves to be *Xylopia aethiopica*. Mattioli discovered that it came from tropical Africa, and called it *Piper aethiopicum*, but although the drug was well known in the sixteenth and seventeenth centuries, the plant which yielded it was not described botanically until 1813. A still more striking case was *Languas officinarum*, the Lesser Galangal, the botanical source of which was unknown until 1873, although the drug itself had been used in pharmacy for 1000 years. The identification of the drugs in the herbal of Valerius Cordus forms a first step to the naming of those in his ' Dispensatorium ', a pharmacopoeia adopted by the city of Nuremberg.

Miss Sprague dealt with some points of special interest, noted by her while preparing a glossary of the botanical terms used in the herbal. This will be published later. Among new terms introduced by Valerius Cordus were *papilionaceus* and

crenatus. The idea of comparing the flower of a leguminous plant to a butterfly seems to have occurred independently to several botanists in the early sixteenth century, but Cordus was apparently the author of the term *papilionaceus* as used in this connection. He employed the word *crenatus* in the general sense of notched, e. g. ' serrae modo crenatus '—notched like a saw, i.e., serrate. He does not seem to have proposed any special term for the kind of margin now known as ' crenate ', although he noted its occurrence in *Glechoma hederacea*.

Cordus shares with Bock the credit of having discovered that ferns propagated themselves by means of spores. He noted several forms of vegetative propagation, describing the purplish black bulbils of *Dentaria bulbifera*, and the formation of new corms on top of the old ones in *Gladiolus* and *Crocus*, and at the side of them in *Colchicum autumnale*. He pointed out that *Tamus communis* twines ' with the sun ' and *Phaseolus vulgaris* ' against the sun ', and observed the small bacterial nodules on the roots of *Lupinus albus* and *Phaseolus vulgaris*, though he was ignorant of their function.

Cordus paid attention to the arrangement of flowers in inflorescences, describing the flowers of the common fig, *Ficus Carica*, the scorpioid cyme of *Sedum mite*, and the false capitulum of *Echinops sphaerocephalus*, in which the central flower expands first. He often mentioned the arrangement of the seeds in the seed-vessel, remarking of *Capsicum annuum* : ' the seeds are attached to a thick membrane running across the middle of the vessel ', and of *Corydalis intermedia* : ' the seed is attached to both commissures '. He gave a detailed account of the seed of *Strychnos Nux-vomica*, describing the radicle and the two delicate cotyledons.

With regard to ecology, Cordus usually gave the habitat of each plant and occasionally added interesting details. Thus he tells us that *Vincetoxicum officinale*, which generally grows in hilly stony places, is also found in some damp meadows, its seed having been carried down by mountain streams or floods ; and he sometimes lays stress on the nature of the soil, stating, for example, that *Cephalanthera latifolia* grows where there is gypsum in the soil.

Dr. Agnes Arber's remarks were read by the Botanical Secretary, as follows :—I should like, if I may, to congratulate Dr. and Miss Sprague on the completion of their study of Valerius Cordus. Hitherto, Cordus, despite his recognized importance, has been little more than a name to many of us, and it is a great piece of good fortune that his work should have been studied and analyzed so thoroughly by authors who are experts both in modern systematics and in the history of botany.

One point that has struck me particularly in Dr. Sprague's methods is that he often finds it more useful to set Cordus's descriptions side by side with modern *figures* than with modern *descriptions*. This seems to indicate that, in comparing an ancient and a modern description, we are not—as is usually assumed—comparing something imperfect with something of the same sort, but relatively perfect. On the contrary, the old description may be regarded as an abstraction from reality, made from the standpoint of its particular century, while the modern description is merely a corresponding abstraction, made from the stand-point of our own day, which gives a better view in some directions, but in others an inferior one. On the other hand, a representation by a good artist ' dates ', however, far less, and though it is necessarily abstracted to some extent, yet it approaches nearer to concrete reality than either the early or the modern description—it may be said, indeed, to include both.

Miss Sprague has referred to the difference between the early and the modern use of the word ' seed '. It is, I think, regrettable that botanists have taken the existing words, fruit and seed, and twisted their meaning away from that which they bear in common speech ; for it is often necessary to go back to that common meaning. Clement Reid, for instance, pointed out that, for the purposes of his work, he was obliged to use ' seed ' to mean ' the one-seeded unit of dispersal ', whatever its morphological character.

It may be worth noticing that, when Valerius Cordus referred to the ' seed ' of ferns, the observation was not quite new. Dioscorides had stated that ferns were without flowers or seeds, yet Jerome Bock tells us, in his herbal, that the country people in his day believed that the fern bore seed at midnight on Midsummer eve, but that it could be gathered in safety only if charms and sorceries were used. To find out the truth, one Midsummer eve Bock went boldly forth, using no magical rites, but taking two or three honest men to bear him company. He and his friends found fern-seed and returned unscathed.

Finally, I should like to put in a plea for a study of Jerome Bock from Dr. and Miss Sprague, to complete their work on the German Fathers of Botany.

Mr. J. Ramsbottom added that Dr. Arber's remarks were those of one whose extensive knowledge of the herbals was appreciated by all. Having himself had frequently to consult the works of the herbalists, he would like to pay a tribute not only to the care with which Dr. and Miss Sprague had done their work but also to the extremely interesting account they had given of their methods and general results. To those who had no experience of such work the way in which a clue here and a clue there were followed must have suggested

detective fiction: to others it was apparent that valuable and interesting results had been obtained which were well worth the enormous amount of labour entailed.

Mr. T. E. Wallis said the results presented by Dr. Sprague and Miss Sprague must have involved long and careful work about which very little appears in the account put before the meeting. In order to understand the descriptive terms, the authors have spent many years of study so as to be able correctly to interpret the sixteenth century Latin which is used, and the sincere thanks of all interested in these ancient documents is due to them for their painstaking investigations. It might be interesting to note that, in 1934, a facsimile edition of Cordus's 'Das Dispensatorium' was issued by the Association for the History of Pharmacy of the University of Innsbruck. One would like to ask what were the methods used by Valerius Cordus in preparing his descriptions and also, if it was the original intention of Cordus to issue his descriptions without illustrations, for which he appears to have made no provision.

Dr. A. B. Rendle commented on the botanical and historical interest of Dr. and Miss Sprague's communication. He feared that not many modern botanists realized the interest and botanical value of the work of the Fathers of Botany.

Dr. H. E. McMinn (Visitor) also spoke.

The non-unique position in the genus Hypericum of H. peplidifolium A. Rich. By Edith R. Saunders, F.L.S., sometime Fellow of Newnham College, Cambridge.

The variations which have been described as occurring in the floral ground-plan in *Hypericum* are shown in the formulæ set out below, from which it would appear that the species can be grouped into four categories:—

(1) K 5 C 5 A 0+5_x Styles 5.
(2) K 5 C 5 A 0+5_x Styles 3.
(3) K 5 C 5 A 0+3_x Styles 3.
(4) K 5 C 5 A 0+3_x Styles 5.

It will be seen that in categories (1) and (3) the number of members in the one whorl present of the androecium is the same as the number of outer style-bearing carpels of the gynaeceum; that in category (2) the number of style-bearing carpels is less than that of the staminal members; and that in category (4) this relation is represented as reversed, the reduction which occurs in the ground-plan in the androecium being followed by a return in the gynaeceum to the fuller ground-plan of the calyx and corolla.

Categories (1), (2), and (3) are each represented by numerous species, but the existence of the fourth rests solely upon the

ground-plan attributed to a single species—*H. peplidifolium*, which occurs in most high mountain regions (about 4500–8700 feet) in Tropical Africa, including Abyssinia and Usambara.

I have already shown in an earlier communication (3), pp. 313–321:—

(*a*) That the vascular units serving each single group of stamens are derived from trunk-cords which also furnish the petal midribs; hence in all species with a pentadelphous androecium the bundles of stamens are superposed on the petals.

(*b*) That each of these vascular units becomes subdivided into a varying number of strands which serve a corresponding number of stamens.

(*c*) That in all species, whether possessing a pentadelphous or a triadelphous androecium, one such vascular unit is detached from each of the five above-mentioned trunk-cords; but that in species with a triadelphous androecium these units, owing probably to an asymmetry set up through the unequal width and quincuncial arrangement of the sepals, are unequally spaced.

(*d*) That in consequence of this unequal spacing the groups of vascular strands derived from the trunk-cords on either side of sepal 5 originate so close together that they come into contact and coalesce; and that those on either side of sepal 4 similarly come together, so that the triadelphous androecium is not in reality composed of three single bundles, but of one single and two double bundles. It follows that the distinction between the pentadelphous and the triadelphous androecium does not rest on a difference in the number of antepetalous members represented by the whole androecium, but upon whether the groups of stamens representing the members remain distinct or become united.

(*e*) That after the organization of the petal-stamen trunk-cords the residual central cylinder is reconstructed. The bundles which serve the succeeding whorl (that of the styled carpels) are delimited and turn outwards on the alternate (sepal) radii in the pentadelphous five-styled species of category (1). But in the three-styled species of categories (2) and (3) a new symmetry comes into being which brings two of the three outer carpels on to quite new radii.

In view of the above relations, statements as to the existence of a category in which reversion normally occurs in the gynaeceum to a 5-radiate arrangement after restriction of space had led to 'condensation' of the original 5-radiate scheme of the perianth-whorls to a 3-radiate scheme in the androecium (see 4, above) seemed to call for fresh and incontrovertible evidence in their support if they were to continue to be accepted.

Such evidence is not very easily obtained, owing to the restricted distribution of *H. peplidifolium* and its scarcity in some of the more accessible regions. Herbarium material, even were it available, is unsuitable for this purpose, owing to the fragility of the staminal filaments and the poor development of their vascular bundles. Recently, however, through the assistance of the authorities of the East African Agricultural Research Station at Amani and after a generous expenditure of time and labour on the part of Mr. P. J. Greenway, to whom I am very greatly indebted, a small amount of flowering material was forwarded to me which had been collected on the mountain grass-lands of the E. Usambaras where the plant is extremely rare. This material furnished seven flowers from different individuals. All seven had a five-styled ovary with five loculi, but not one had a triadelphous androecium. In each specimen the stamens, which varied in number from 15 to 19, were plainly grouped into five antepetalous bundles, the filaments in each bundle being united for a short distance. The number of stamens in each bundle (arranged in descending order) in six of the flowers was as follows :—

Flower.	Number of stamens in each of the five bundles.				
1	6	4	3	3	3
2	5	4	3	3	3
3	4	4	3	3	3
4	4	3	3	3	2
5	3	3	3	3	3
6	3	3	3	3	3

In the seventh flower, as in the other six, the stamens were in five bundles, but, owing to the withered condition, the precise composition of each was not determined.

From the above facts it would appear that *H. peplidifolium* does not conform to the hitherto accepted formula $A0 \mid 3$, but that this species must be added to those included in category (1), in which the ground-plan is pentamerous throughout. For, although the number of specimens examined was so small, it can scarcely be supposed that material so uniform was not typical. Especially since the full pentamerous ground-plan undoubtedly represents the ancestral form from which categories (2) and (3) have arisen, not as the result of the suppression of individual members of any whorls, but through processes of reconstruction leading to reduction which, where this means of meeting the spatial conditions was inadequate, is preceded by certain fusions. It may then be concluded that the combination of a triadelphous androecium with a five-styled ovary, a combination which in the light of our present knowledge is highly improbable, does not in fact occur as a specific type, and that

the correct formula for *H. peplidifolium* is K5 C5 A0+5_x G5-styled.

In conclusion, passing reference may be made to another character of this species, incompletely or inaccurately described in some of the earlier accounts. In his original description of the plant Richard (2) states the leaves never have the black dots present in *H. humifusum*, from which, however, he considers it impossible to separate *H. peplidifolium*. In D. Oliver's account (1) mention is made of the presence of intramarginal dots only on the sepals. In the material from Amani, however, black dots were very abundant, not only on the margins of the sepals, but also on those of the leaves and even of the petals.

References.

(1) Oliver, D. 1868. Flora of Tropical Africa, i. p. 155.
(2) Richard, A. 1847–51. Tentamen Florae Abyssinicae, i. p. 95.
(3) Saunders, E. R. 1936. On Rhythmic Development and Radial Organisation in the Flower. *Journ. Linn. Soc. Lond.*, Bot. 1, pp. 291–322.

Dr. A. B. Rendle congratulated Miss Saunders on an interesting contribution to taxonomic botany in solving the problem of the position in the genus of *Hypericum peplidifolium*.

The following papers were read in title :—

'A collection of Benthic Amphipoda from Icelandic waters, and its relation to similar material from the North Sea.' By D. S. Raitt, B.Sc., Ph.D., F.L.S.

'A cytological study of some New Zealand species and varieties of *Danthonia*.' By J. W. Calder, B.Ag., M.Sc., Canterbury Agricultural College, Lincoln, New Zealand. (Communicated by the Botanical Secretary.)

'A new species of Rhabdocoel and its method of feeding.' By L. E. R. Picken. (Communicated by Dr. G. S. Carter, F.L.S.)

The President announced that his Presidential Address, to be given at the Anniversary Meeting on 24 May 1937, will deal with 'James Eights, a pioneer Antarctic naturalist'.

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CATALOGUE OF MANUSCRIPTS, Part II.

The Catalogue of the Manuscripts in the Library of The Linnean Society of London, Part II. Caroli Linnaei Determinationes in hortum siccum Joachimi Burseri. The text of the Manuscript in the Linnaean Collections, edited by Spencer Savage, F.L.S., is now ready for delivery to Fellows and others. This Part of the Catalogue, which is in quarto, extends to 78 pages. The edition is limited to 500 copies.

The price to Fellows is 7s. 6d., carriage free; to non-Fellows, 10s. 0d.